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NATIONAL ELECTRIC LIGHT CONVENTION.

The coming convention of the National Electric Light Association at Denver and Colorado Springs gives every promise of being a record-breaker in attendance, notwithstanding that the place of meeting is far distant from the "population center" of the membership of the association. At one time it was a question whether the convention should be held in Denver or in Colorado Springs, and the compromise effected, which included meetings at both places, was a most happy outcome. In progressiveness, in methods of management, the electric lighting plant of the capital city is at present perhaps the most notable in the United States. To obtain a close view of the methods that have enabled this plant to increase its income almost four-fold in a comparatively few years, is in itself an ample inducement to justify central station men to join in the trip to the Rockies. The excursion to Colorado Springs, the fame of which as a beautiful resort is so well deserved, rounds out fully a most tempting programme.

The programme of the papers to be presented at the convention has now been issued, and will be found elsewhere in our pages this week. It is a very attractive bill of fare, and the intention of the officers of the association is that it shall be fully discussed. To this end the large attendance of central station engineers and managers will contribute most happily, so that the net practical results will be a justification of the long trip that most of the delegates must make to the convention city. Those who propose to participate in the convention, whether from the East or the West, should not delay in securing transportation in accordance with the plans already made and announced by the association. The reservations already exceed what was expected for the special trains, and late applicants will probably find themselves seriously embarrassed in securing accommodation.

A REMARKABLE CONGRESS.

The steam railroad industry is to be heartily congratulated upon the scope and success of the International Railway Congress in Washington during the past two weeks, and upon the remarkable display of apparatus and material associated with the convention. Both aspects of the gathering have received attention at our hands, but only personal participation could give an idea of the extent of the technical work done and the nature of the exhibit. To ourselves it has been a matter of great pleasure to note the prominence of electricity in connection with this notable event, evidencing not only great opportunities at the present time, but the opening up of a vast new field in the near future, for the conquest of which the electrical forces, trained, drilled, expert and enthusiastic as any Japanese army, are ready and eagerly waiting.

This is indeed a psychological moment in the passing of steam railroads under the new régime of electricity, and in future years we may all look back upon the congress as the landmark from which to register advance. That which the New York Central and Pennsylvania Railroads are doing in America; that which the Lancashire & Yorkshire and other roads have done in England; that which the Orleans and other lines in France have tried with success; that which the Mediterranean system in Italy has proved available—cannot long be delayed in its universal adoption. The revolution may not come

quite so quickly or in quite the manner expected, but that it will come and is even now dawning upon the railroad world, no observant man will or can deny; and herein lies abundant encouragement for those who have helped introduce the greatest and most beneficial advance in railroad work since Stephenson, Ericsson, Stevens, Cooper and Evans did their pioneer work with steam and on the steam locomotive. Their glory is none the less because younger and newer geniuses take the lead with the younger motive power at command. "Thus God fulfills Himself in many ways, lest one good custom should corrupt the world."

Leaving poetry for practice it is interesting to note that Mr. Westinghouse, in his pregnant remarks at Washington last week, emphasized forcibly the beginning of this new electrical régime, and that Mr. Stuyvesant Fish, in his presidential address, took occasion to note how the competition of the trolley had checked the growth of steam railway passenger traffic in the United States. The next step indicated by both these typical leaders of action and invention has begun in the acquisition of trolley lines by the railroads and in the prompt adoption of electricity itself for main line traction. Greater yet and more fraught with tremendous economic and social consequences are the electrical changes now impending.

The Mercury Arc.

Dr. Weintraub's paper, recently presented before the Boston meeting of the American Electrochemical Society, and abstracted elsewhere in this issue, is interesting and suggestive, although, as is always to be expected of researches from a commercial laboratory, it lacks many details which would have been welcomed. The starting of the mercury arc is a beautiful example of the application of theoretical considerations to practical apparatus. That an e.m.f. great enough to start a discharge across the gap between the electrodes would be followed up by an arc was, of course, to be expected; but that it would do it in just the way it does and so easily is an admirable illustration of the theory as developed by Thomson and others. More and more do conducting liquids and gases seem to be in a species of unstable equilibrium ready to be overset by the first stress that starts ionization. As a practical matter it is necessary to start a mercury arc or any other illuminant promptly and without a chance of failure, so that every additional method of accomplishing the result is useful. One should not, however, make a fetish of ionization, and we think that Dr. Weintraub is drawing a pretty fine line in his separation of the purely electrical from the thermal effects. The two behave somewhat differently, to be sure, but after all, that physical effect of electric stresses which we are pleased to call ionization, comes pretty near to being a general condition at the boundary between two media of different physical constants during the transition of energy across that boundary. We have in these days a terrible facility at giving new names to old things and jumping at novel conclusions without due deliberation, merely because they are novel. Witness the attempts to throw the burden of maintaining the earth's heat upon poor hard-worked radium. The new theory may be correct, of course, but it is a rather formidable thing to build up upon the decomposition phenomena of a few milligrams of the haloid salt of a metallic mixture of uncertain composition.

But to return to the mercury arc. It is interesting to note that it improves in working with the current density of the cathode, much as in the case of any other phenomenon involving cathode discharges. At high current density the arc will work well with a considerably reduced total volume of current. It would be interesting to know the effects of this particular change upon luminous efficiency. In arcs of this sort the relation between efficiency and temperature is by no means clear; in fact, it is exceedingly difficult to define what one means by the temperature of a mercury arc. Any light-giving atom of gas may perhaps be assumed to be at a high temperature, but even then one has to define the temperature of an atom. This is a very different thing from defining the temperature of a mass of heated gas, which can be fairly done in terms of its dynamical properties. Perhaps the most striking thing brought out by Dr. Weintraub is the fact that the conductivity of the mercury arc is practically proportional to the current, so that the voltage across the arc is almost independent of the current, it being a case of every ampere furnishing its own ions. Of course, in commercial lamps this condition may not hold rigorously by reason of changes of pressure and of temperature, but it is even then approximately correct. Another curious feature is the way in which the arc can be smothered by an excess of mercury vapor, presumably at reduced temperature, which raises the resistance of the tube and ultimately puts out the arc.

The practical side of the mercury arc, touched upon only incidentally in Dr. Weintraub's paper, is of the utmost interest. In the first place, it certainly does give a light of enormously high efficiency albeit at present of forbidding color. In the second place, it gives a beautiful static rectifier of alternating currents, at least for moderate amounts of energy. As a means of furnishing direct current for arc lights, charging accumulators, and the like, it is already coming into commercial use with good results. The important question for the near future is the development of this function. No data on the economic limitations of the process are yet at hand, and until they are investigated one must suspend judgment. The present price of mercury rectifiers seems to be based on the price of motor-generators, and is consequently too high to give a fair idea of the commercial value of the process. Another very interesting point in this connection is the practical effect of working rectifiers upon the alternating system as a whole. Of course, casual rectifiers can be easily managed, but what will be the characteristics of a system of which, say, half the output is in rectifiers? As to the mercury arc as an illuminant, everything turns upon the possibility of getting some red rays into the spectrum. The alkali metals are understood to attack the glass ferociously, and some way of averting this would be most valuable. A recent series of foreign experiments has been made on cadmium amalgam, but the arc from this substance seems very hard to start, and, moreover, cadmium is far from rich in red rays. It has one brilliant one, to be sure, but a large part of its radiation is in the green and blue, to say nothing of a very powerful series of ultraviolet lines. In short, it does not strike one as promising. Certain it is that Dr. Weintraub and his colleagues have been doing a great amount of valuable work on the arcs in metallic vapor, and if there is anything to come out of the subject they are on the road to finding it. So efficient a source of light and so valuable a rectifying apparatus deserves persistent attention, and in any event the scientific side of the investigation is important.

Electrical Units and Standards.

A very interesting discussion on the above topic has occupied two recent sessions of the Institution of Electrical Engineers in London, an abstract of which appears in the columns of our esteemed contemporary, *The Electrician*, in its issues of April 14 and 21. The discussion was opened by Mr. W. Duddell, who was the honorary secretary of the delegation from the Institution of Electrical Engineers to the International Electrical Congress of St. Louis. It will be remembered that the Chamber of Delegates at St. Louis recognized that discrepancies exist between the laws relating to electric

units, or their interpretations, in various countries, which require consideration with a view to securing practical uniformity, and recommended that an international commission should be appointed to take the matter into consideration. It was stated in the recent discussion by Dr. Glazebrook, one of the British delegates to the chamber at St. Louis, that the German, Italian and probably the French Government authorities had given their adhesion to an international conference in Europe, and that the British Government was also prepared to assist. The recent discussion covered all of the subjects laid before the St. Louis Congress, and it was hoped might lead to the formulation of views by the membership of the British Institution of Electrical Engineers to assist the proposed international conference. The discussion in London mainly followed three distinct but correlated subjects, namely, the relations of electromagnetic units in theory, the condition of legalized national electrical standards, and the condition of practical laboratory and workshop electrical standards. Mr. Duddell appears to have presented the matter very clearly in opening the discussion.

As regards the first topic of fundamental units, Lord Rayleigh admitted that the Heaviside amended system of electromagnetic units was more convenient and rational than the existing c.g.s. system, so far as concerns the constant 4π; yet the fact that the c.g.s. system was now internationally established made its change a very serious question. Prof. S. P. Thompson spoke in favor of the Giorgi system of units, which furnished the subject of a paper presented at the St. Louis congress. As regards the second topic, there was a difference of opinion as to whether the legalized concrete standards ought to be based upon a standard ohm and standard volt, or on a standard ohm and standard ampere. Lord Rayleigh seems to have favored the latter pair of fundamental standards, for the reason that the ohm itself was not above suspicion in regard to certainty, and that the absolute determination of the volt involved the accuracy of the ohm. Mr. Trotter favored the adoption of the ampere and the ohm, the ampere being ultimately referred to electrochemical determination, but proximately determined by a gravitational ampere-balance. As regards the third topic, it seems to have been generally agreed that for practical purposes in the laboratory and workshop, the standard cell and the standardized resistance coil would remain the recognized bases of electrical measurement.

The mental attitude towards the general subject depends upon the side by which it is approached. The physicist, the electrical experimentalist, the engineer, the station manager and the business man regard the subject from essentially different viewpoints. We think that for most practical and business purposes the condition of the ohm, volt and ampere are satisfactory. Until a degree of precision is reached of a fraction of one per cent., there is complete unanimity as to the practical, commercial or legal value of any of these quantities, or of their derivatives, the watt, coulomb, henry, etc. When, however, we come to laboratory tests for the standardizing or calibration of voltmeters, or when we consider the testing of the candle-power or candle-hour lifetime of incandescent lamps, we find that although the ohm is the same to a few hundredths per cent. in the standard national laboratories of Berlin, London, Paris or Washington, there is an appreciable difference of rather less than one-tenth of one per cent. between the value of the volt in these various laboratories. Thus a Clark cell, which is legally adopted as having an e.m.f. of 1.434 volt at 15° C. in the United States and in some other countries, it is accepted as having only 1.4329 volt in Germany, and also in the Board of Trade Laboratory of Great Britain. This discrepancy makes a small but perceptible difference in the candle-power of standard incandescent lamps calibrated for photometric secondary standards and also makes a small but readily appreciable difference in the candle-hour life record of incandescent lamps run at a line voltage maintained in adjustment to a standard voltmeter reading. To the electrical engineer, the station manager or the business man it is a matter of indifference whether the Clark cell has actually 1.433 volt or 1.434 volt at 15° C. That is a question for the physicist to consider. The electrical engineer only wants to have the same voltage accepted for the Clark cell in all parts of the civilized world. At the present time we occasionally find in literature and in official tests two ratings side by side, viz.: one for the legally accepted Clark cell e.m.f. of 1.434 volt, and the other for the provisional e.m.f. of 1.433. It is this needless and objectionable reduplication and uncertainty that calls for amendment. The legal value can probably only be changed after international agreement of such a commission as, it is hoped, will soon be appointed.

Again, as regards the ohm and volt, versus the ohm and ampere, for fundamental concrete standards this is a matter which has little concern for the electrical business or the electrical engineer serving that business. Whichever pair is adopted in the national laboratories, the engineer is now using and is likely to continue to use the standardized resistance and the standard cell, with a potentiometer, for his work. It does not matter to him whether the calibration of his standard cell was performed through the use of a primary standard ampere working through a standard ohm, or whether it was through the use of a primary standard volt. From the standpoint of the physicist, the question is, however, one of great importance to the national laboratories. At present the matter is in somewhat loose condition, from a legal standpoint. If the national laboratories could come to an agreement upon the matter, and adopt such fundamental standards as could be most definitely reproduced and maintained, the legal requirements could probably be readily adjusted. An analogy is presented in the metric system. The international meter was originally defined as a certain subdecimal of a quadrant meridian through Paris. A concrete standard was established with the intention of embodying the definition. It transpires that the standard is a little short of the real quadrant subdecimal through Paris and that some other quadrant meridian would have to be taken on our somewhat irregular spheroidal earth, in order to comply with the standard. Nobody cares, however, just what meridian of the earth fits the international meter. All that we care about is the permanence, reproducibility and uniform international agreement upon the standard meter. The exact numerical relation of the meter to the earth's meridians is a matter of interest to geodesists only. But it would be deplorable if the legal and nationally recognized meter in the United States were different in the least appreciable degree from the legal and nationally recognized meter in Germany or England.

As regards the fundamental electric units, there is virtually only one system in which theory is taught, and that is the c.g.s. system, irrational as it may be, and there is only one system in which practice is applied, and that is the volt-ampere-ohm derived system. This is an unfortunate division between theory and practice, which at present cannot be helped. The Giorgi system seems to be capable of solving the difficulty, by making one and only one system out of the two, using the ampere, kilogramme and second. But unless there is some hope of making the Giorgi system international, it is surely better to avoid introducing it, for it will make yet another system to learn and yet another chance of confusion. This is a matter of great interest to the physicist, and to the electrical engineer, but of no appreciable interest to the business man.

Programme of the Denver Lighting Convention.

Secretary Dudley Farrand has issued the following preliminary notice of programme:

Should any of the members of the National Electric Light Association have become impressed with the idea that sight-seeing and entertainment are to be the only features—or even the most prominent features—of the twenty-eighth convention, to be held in Denver-Colorado Springs June 6 to 11, they are destined to agreeable disappointment. President Davis has prepared a programme that will make the business sessions better attended than ever before, and he intends to have the papers and reports fully discussed. Among the numbers already in press are the following:

"Wrinkles," H. C. Abell, editor; "Question Box," Homer E. Niesz, editor; "The Nernst Lamp, Its Present Performance and Commercial Status," by E. R. Roberts; "Data Re-tree Trimming" (compiled in the office), by George W. Brine; "Report on Purchased Electric Power in Factories," by E. W. Lloyd; "Report on Present Methods of Protection from Lightning and Other Static Disturbances," by Alex. Dow; "Some Investigation of Inductive Losses," by E. P. Dillon; "Insulation Testing Apparatus and Methods," by C. E. Skinner; "The Choice of an Insulated Cable," by Wallace S. Clark; "Sign and Decorative Lighting," by La Rue Vredenburgh; "Automatic Synchronizing of Generators and Rotaries," by Paul MacGahan; "Series Alternating-Current Motors for Industrial Work," by Clarence Renshaw; "Long-Distance, High-Tension Transmission in California," by John A. Britton; Report of the Committee on Progress, by T. Commerford Martin.

The "Question Box" is so voluminous that it seemed for a time impossible to get the cover on, but it has finally been closed and is in the hands of the printer. Mr. Abell reports about 120 "Wrinkles," and about a dozen papers and reports are still to be printed, in addition to two or three reports that will be discussed in executive session and will not be in print.

The "flow of soul" that the entertainment committee is preparing will not be allowed to interfere in any manner with President Davis's "feast of reason," and every central station manager will be amply repaid for the time and money he may expend in attending the convention.

Monday, June 5.—Arrival of delegates. Reception by local committee. Informal reception, with music, at headquarters, the Brown Palace Hotel.

Tuesday, June 6.—Morning—Business session in ordinary at Brown Hotel. Addresses of welcome by Governor J. F. McDonald, Mayor Speer, of Denver, and Mayor Hall, of Colorado Springs. Afternoon—Business session. Country Club luncheon for ladies. Evening—Theatre party at Elitch's Gardens.

Wednesday, June 7.—Morning—Business session. Afternoon—Broncho-busting contest at D. A. C. Park. Evening—Business session until 10. At 10.30 an "athletic" smoker at either the Democratic Club or Coliseum Hall. Party at Orpheum for the ladies (if theatre is open).

Thursday, June 8.—Morning—Business. Afternoon—Business. Street car rides for the ladies. Evening—Business. Serenade by the George W. Cook drum corps.

Friday, June 9.—Morning—Entire party transported to Colorado Springs. Afternoon—At Colorado Springs, drives to all of the famous scenic points. Visits to the power plants. Trip up Pike's Peak. Evening—Dance and concert at the Broadmoor Casino.

Saturday, June 10.—All day—Special trains to the Cripple Creek district and return.

Sunday, June 11.—All day—Trips to the scenic points about Colorado Springs, each delegate taking those he was unable to take on Friday.

Monday and Tuesday will be devoted to excursion parties arranged for those desiring to go over to Moffat Road and the Loop.

President Davis has been visiting New York during the past week and has been in constant attendance at headquarters arranging the above details and other matters. The programme is so rich in good papers and reports, no little care has been required in arranging for its proper consideration, especially in view of what promises to be an unprecedented attendance. A good deal of thought and work is now being bestowed also upon the special trains by Mr. G. F. Porter, master of transportation.

New York State Lighting Commission.

The New York State Senate, on May 4, passed a bill creating a state commission of gas and electricity, with power to regulate the price of gas and electric light and power, and providing for the control and supervision of gas, electric light and power corporations. The commission is to be composed of three members, to be appointed by the Governor, each to receive a salary of $8,000 per annum. It is authorized to investigate and ascertain the quality of gas supplied and the operations of persons, corporations and municipalities in supplying gas and electricity for light, heat and power or in transmitting the same, and may order such improvements as will best promote public interests, preserve the public health and protect those using gas and electricity.

The commission may fix the standard of power and purity of gas and establish a standard of pressure at which gas shall be delivered. It may prescribe methods of keeping accounts and books by gas and electric corporations and will have supervision of the power companies at Niagara Falls and other places. It may require each corporation to file an annual report in detail, showing all of its financial operations for the year and has power to examine the books and affairs of any corporation pertaining to the affairs being investigated by it.

The commission is authorized to supervise the inspection of gas and electric meters by any State or municipal officer, and may adopt rules to govern such tests and see that these officers do their duty. It may appoint an inspector of electric meters.

Hereafter no gas or electric light or power company incorporated after this bill becomes a law shall transact business within this State until it obtains a certificate of authority from the State commission. Nor shall a municipaliy establish a municipal lighting plant without the consent of the commission.

No gas or electric light corporations hereafter incorporated shall issue any stock or bonds without the approval of the commission, and no existing corporation shall increase its capital stock or bonded indebtedness without such consent. A gas or electric corporation shall not transfer or lease its franchise or plant, nor acquire the stock or bonds of any other corporation engaged in a like business without the commission's consent. The bill is now in the hands of Gov. Higgins for his action.

Railway and Lighting Service From the Same Generator.

The Cedar Rapids & Iowa City Railway & Light Company operates both the lighting service in Cedar Rapids and the cars on 27 miles of interurban line between Cedar Rapids and Iowa City from the same polyphase current generators. The voltage regulation on the lighting line is excellent, being in fact much better than is common on the lighting system in cities the size of Cedar Rapids. Bristol voltmeter charts, which Mr. W. J. Greene, manager of the company, was exhibiting to his friends at the Iowa Electric Association Convention, showed less than one volt variation either way from normal. That the voltage regulation must be good is also demonstrated from the fact that large numbers of Nernst lamps have been installed in Cedar Rapids, the number having increased from 500 to 1,000 during the past year, and it is coming to be well recognized that to operate Nernst lamps with reasonable cost for renewals requires fairly good voltage regulation or at least requires that the voltage shall not be above normal for any great length of time, the Nernst lamp being as susceptible to abnormally high voltages as a 3.1-watt incandescent lamp.

The reason for this remarkable good voltage regulation with fluctuating interurban railway load operated from the same bus-bars as the lighting service at Cedar Rapids is that the company keeps running in the station an 180-kw generator operating as a synchronous motor to improve the power factor and to regulate the voltage of the bus-bars. This synchronous motor has a Chapman voltage regulator connected in its field circuit. This regulator acts to cut resistance in and out of the field circuit to maintain a constant voltage just as if the motor were a generator. This motor regulates the power factor and voltage well for the entire output. The load on the station sometimes reaches 1,000 kw. From two to three cars are operated on the interurban road.

Electrical Exhibition in Boston.

The National Electrical Contractors' Association will hold its convention and exhibit in Boston July 15 to July 22, 1905. For this purpose the entire Mechanics Building, containing 83,000 sq. ft. of exhibit floor space, has been engaged and is now being rapidly sold to the manufacturers and jobbers throughout the country to exhibit their lines. The annual convention of the association will meet during the week in the same building, thus bringing all the contractors of the country, as well as the architects, mechanical and electrical engineers, street railway officials and other prominent mechanical and electrical people who are directly interested and who are to be the guests of the association that week, into direct contact with the exhibitors.

The convention will be entertained by the Electrical Contractors' Association of Massachusetts. The committee appointed to have charge of the exhibition consists of Messrs. J. P. Coghlin, F. L. Barnes, A. T. Sampson, F. A. Richardson and T. T. Kelly. This committee has secured the services of Chester I. Campbell to act as general manager of the show and who will devote his time from now on in making the show the largest of its kind ever held.

The building in which the exhibition and convention will be held has a national reputation for exhibitions and always draws a large number of people from New England. It has become famous for its mechanical exhibitions, which are held every other year. During the late automobile and power boat show, held in this building, 47,500 people were credited as having passed the gates on the opening night.

Independent Telephone Consolidation.

With regard to a movement already noted in these pages, a special dispatch from Rochester, N. Y., of May 6 says: "Announcement was made in Buffalo this week that the Consolidated Telephone Company had bought the Frontier Telephone Company, which has been in operation about two years in competition with the Bell company. The Consolidated is a "holding" company, with a capital stock of $10,000,000, and controls the Interocean Telephone & Telegraph Company, which is the main competitor of the Bell company in long-distance business in western and central New York.

The announcement of this combination followed close on the incorporation of the Independent Telephone Securities Company, promoted mainly by Rochester capitalists, which has acquired control of all of the independent lines in six counties—Otsego, Herkimer, Oneida, Lewis, Jefferson and Oswego, including the Utica exchange. The capital stock of the Independent Securities Company is $800,000, but it has been authorized to make a mortgage of $15,000,000 to a Rochester trust company to secure a bond issue of equal amount to be used in the acquisition of other independent lines throughout the State.

The new company is in reality a "holding" company, controlling, but not operating, the systems directly. Negotiations are now under way for the merger of the Rochester Telephone Company, the Bell's competitor in this city, with the Independent Securities Company. When this is accomplished it is expected that an effort will be made to combine with the Consolidated, which has just bought the independent company in Buffalo.

Electric Tablet System for Railroads.

United States Consul Dillingham, at Auckland, New Zealand, has transmitted to the State Department a very full account of the electric tablet system used on the railroads of New Zealand. The purpose of the electric train tablet system is to prevent more than one train being between any two tablet stations at the same time, and when no train is in the section between the tablet stations to permit a train to be started from either end. This is accomplished by every train carrying a tablet; one tablet only being obtainable from the tablet instruments of the same section at the same time.

The apparatus is so constructed as to render the issue of the train tablet absolutely safe at either end of a section and under the control of the station which the train is approaching. No train tablet can be issued from station Y without the consent and co-operation of station Z, and when once a station has issued a train tablet no other tablet can be obtained for the same section until the one issued has been delivered at its destination and placed in the instrument there or reinserted in the instrument from which it was withdrawn. The meeting place of trains can be altered immediately with perfect safety.

The signaling of trains on the electric train tablet system does not in any way dispense with the use of fixed, hand, or fog signals whenever and wherever such signals may be requisite to protect obstructions on the line.

The construction of the apparatus is not described, practically the entire article being given up to the rules and regulations adopted for the operation of the system.

New English Patent Rules.

The new English patent rules, which formed the subject of an article in our issue of March 18, from the pen of Mr. W. B. Vansize, do not appear to meet with general satisfaction. According to the London *Electrician*, after less than three months' experience of the working of the Act, a widely signed memorial has been presented against one of the rules which have been issued to give effect to its provisions. This memorial was forwarded to the President of the Board of Trade by Sir Lloyd Wise, the distinguished patent agent, and is signed by a number of manufacturers, consulting engineers and patent experts. Briefly, the petitioners ask for an amendment of the rule by which, if the Examiner at the Patent Office considers that the subject matter of a patent has been wholly or in part anticipated by previous patents, the patent may only be issued to the inventor bearing an officially worded note enumerating these previous specifications. In itself, this may not, says our contemporary, seem a great grievance, for, at first sight, it would not appear unreasonable to refuse to grant the patent at all if it is invalid. And if the patentee thinks he knows better than the Examiner, and desires to take all risks, he is a brave man and will not fear the "ear mark" above referred to. The real reason for this loud chorus of disapproval on the part of experts must, therefore, be sought below the surface, and it is not hard to find. It is simply that they have no confidence in the judgment of the Patent Office Examiners on the question of anticipations, and they think, not without reason, that, in the case of a good invention by a good inventor, the inventor himself will have a better knowledge of his subject than the Examiner, and be able to judge better than he whether the suggested anticipations really invalidate his patent. But the point that is still obscure is, what then can be the object of an official search at all? Since the main object of the new Patent Act is to provide for this search, our contemporary contends that this part of the Act is based upon a false principle altogether.

Until the recent amendment in the patent law, the Patent Office simply granted a patent to any inventor who applied for one and specified the nature of his invention in the manner officially prescribed. "The grant of a patent constituted no guarantee as to the novelty of the invention, but by the excellent classification of the files of patents of all countries and the voluminous collection of technical books and periodicals in the free Patent Office library, the inventor was given every facility to ascertain for himself whether he had actually made a new invention or not. But in Germany and in America the Patent Office itself institutes a search before granting a patent, and four years ago, when the Departmental Committee reported, the unwholesome fashion of decrying our own customs in industrial matters in comparison with German and American methods was at its height. So a somewhat similar procedure had to be inaugurated in this country, but Parliament was too timid to give full authority to the Departmental Official, and thus the search is only a partial one, and the applicant may have his patent, even if the officials are of opinion that it is invalid. The search is merely made through the British patents of the preceding fifty years, and it must not follow from the grant of a patent, even without the official endorsement to which exception is now taken, that the specification describes a new invention. The same invention may have been described in its entirety in any or all of the British and foreign technical journals, or it may have been previously well known to the general public, but the Patent Office can take no official cognizance of this fact. Thus, if the inventor desires to satisfy himself that his patent is secure, he has still to

make a complete investigation on his own account; but he has, nevertheless, to pay the extra fee of £1 now imposed to defray the cost of the partial search made in the Patent Office." In conclusion our contemporary states it cannot agree with Sir Lloyd Wise and his colleagues that it is only the new rules rules that are at fault, and it asks for a new Act of Parliament revoking Section 1 of the Act altogether.

Higher Education as Influenced by Cornell.

In an after-dinner speech at an annual banquet of Cornell University Alumni, held in Chicago, Mr. Walter C. Kerr spoke of the active part Cornell has played in the development of higher education in this country. Among the doctrines of Cornell, he said the one of first importance was the declaration that all kinds of education are equal; that there is a natural relation between the so-called liberal and utilitarian courses of study. The policy of those who laid the foundations of Cornell was to do the right thing every day and all the time as opportunity offered without too fixed a goal, but trusting that the results would be the best that right could make. They went as far as they could see, and then saw how far they could go.

At one time an educated man was perforce a classical man; and since education led chiefly to the learned professions, the few who in the early days received college training were fairly fitted for their life's work. As time went on institutions grew in size and multiplied in number, and finally we began to hear whispers from the practical world that college education was a failure; that men who spent four years and thousands of dollars in academic halls were less fitted for the activities of the world than those who spent these developing years in business or other puruits. Then came specialization in education.

As to the so-called specialized courses, these are only names. They are no more special than the humanities, and some are scarcely so highly specialized. There is no such thing as liberal education, liberal arts or liberal anything, as distinct from specialized departments of knowledge. We have heard too much about knowledge for its own sake versus knowledge for use. All knowledge is for use; all education is for action. The engineer uses mechanics and thermodynamics in a certain direct way; the architect uses art and constructive knowledge in a similar way; the lawyer uses his knowledge in a less material way; the classical or philosophical man uses his acquirements in a different way, but if he does not use them they are useless. All education is liberal or all is technical, according to our definitions, but all is for use.

When it is observed that less than 25 per cent. of students follow classical pursuits when left free choice, and that over 75 per cent. elect professional and industrial education, there is good reason to believe that this is about the proportion in which men's minds are fitted to receive benefit from the acquirement of the respective classes of knowledge and training. Mr. Kerr, therefore, considered that instead of a decadence in the humanities, they are elevated because their representatives are men whose minds are fitted to take such education and who will, therefore, conspicuously represent the best possibilities of classical training applied to those to whom it is adapted.

Before Cornell there was virtually one kind of education with a few minor tendencies to departure. A few technical institutes had been established, savoring more of the trade school than engineering. Cornell distinctly segregated men, methods and types of education, and put upon them the stamp of equality. She said by word and not act: All these things are good, and all are adapted to the various conditions of man. Cornell had nothing which was a thing apart nor had she anything which she considered next door to liberal education. It was all liberal; the whole atmosphere was liberal; the spirit was that of toleration, generosity and good-fellowship. As Cornell progressed there emanated from her a flood of revolutionary change in educational methods which swept rapidly through the Western institutions, most of which are confessedly founded on the Cornell basis; and slowly but nevertheless surely little streamlets crept into the older Eastern colleges, where, more or less disguised in name, and with little or no credit given to their source, the same principles and motives have gone to help warm a somewhat chilly atmosphere. These forces are still at work and expanding.

This is the meaning of the various kinds of education as exemplified at Cornell. In the last analysis they will be the various kinds exemplified throughout the land. The spirit that there is room for all and everything is the spirit of Cornell, which recognizes that all education is equal; that training is training wherever you find it; knowledge is knowledge no matter of what it consists; that human effort is human effort no matter to what it is applied, and that when it has singleness of purpose and is resourceful it is effective.

In conclusion, Mr. Kerr said of Cornell's first president, Andrew D. White, that while others gave generously from their abundance, he was Cornell's greatest benefactor, because, born with a silver spoon in his mouth and cradled in the lap of luxury, fitted by education, culture and opportunity to move in the courts of kings, he came to the little village of Ithaca and on its hilltop devoted the best twenty years of his life and his spirit to Cornell University.

Telephones on Shipboard.

The application of the telephone to use on steamers is a different and much more difficult problem than a land installation, for the reason that the vibration of the ship has a neutralizing effect upon the operation of the apparatus. These difficulties have, however, been overcome, and all modern steamers have a very complete telephone equipment.

Two very elaborate telephone systems are being installed on the steamer *Dakota,* now under construction for the Great Northern Company. One is an exchange of the ordinary private plant type, which places the occupant of each room in communication with 150 other stations in different parts of the boat, and the other is an intercommunicating system which is made use of in the boat's administration. The officers, in making use of the latter, do their own switching. It will largely supplant the gong and jingle systems and the marine telegraph. It extends between the navigating and engine room stations.

The stations are the bridge, the afterbridge, crow's nest, port and starboard engine spaces, wheelhouse, chief engineer's room, chief electrician's room, central electric lighting station and the dynamo shelf.

The six exposed stations have water-proof instruments. The holding case is of copper. The talking and listening parts are connected, so that all the officer or sailor has to do is to put the receiver to his ear. A great deal of ingenuity has been exercised in the construction of the instruments in such a manner as to exclude the water and moisture of the air.

Under the new order of things, when the lookout, high up in the crow's nest, sights an object on the sea, instead of raising the cry, as he did formerly, he will simply open a copper telephone box and transmit the intelligence over the wire.

The Electric Drive in Cotton Mills.

At the recent meeting of the New England Cotton Manufacturers' Association, Mr. Sydney B. Paine contributed a paper giving the result of a test of a cotton mill equipped with electric power. He stated that he has a record in detail of 128 different textile corporations which are using about 90,000 hp of electric motors, and it is a conservative estimate that approximately 175 textile mills in this country are using electrically about 140,000 hp. The late United States Census Report shows that 22 mills are driven entirely by current generated by outside and independent corporations, while the same number purchase 5,586 hp to supplement the power generated upon the premises.

The paper gives charts from a recording wattmeter taken from a 200-hp motor operating 52 frames aggregating 11,648 spindles. The spindle speed was about 900 r.p.m. Eleven records are engraved, followed by the data of the test, including the temperature and humidity. The average load was in the neighborhood of 150 hp, the smallest being 148.5 hp and the largest 157 hp. In the latter case the maximum output of the motor was 190 hp; the minimum output of the motor 144 hp; the ratio of average to maximum load 82.7 per cent., and the ratio to the motor rating 78.5 per cent. The average load throughout the test was about 10 hp per frame.

Test of 500-Kw Curtis Steam Turbine.

In December, 1904, the Oshkosh Gas Light Company, of Oshkosh, Wis., installed a Curtis steam turbine and recently has had a thorough test of the outfit made by Messrs. H. M. Byllesby & Co., consulting engineers, the details of the test being in charge of Mr. Otto E. Osthoff, of the engineering staff of this company. The generator is a three-phase, 60-cycle, 2,300-volt machine. The turbine exhausts into a Worthington surface condenser having 2,000 sq. ft. of cooling surface. The step bearing is the latest water-cooled type, water being furnished by two Worthington double-acting pumps at a pressure of approximately 300 pounds per square inch. These pumps are connected in multiple with a water accumulator, which furnishes water

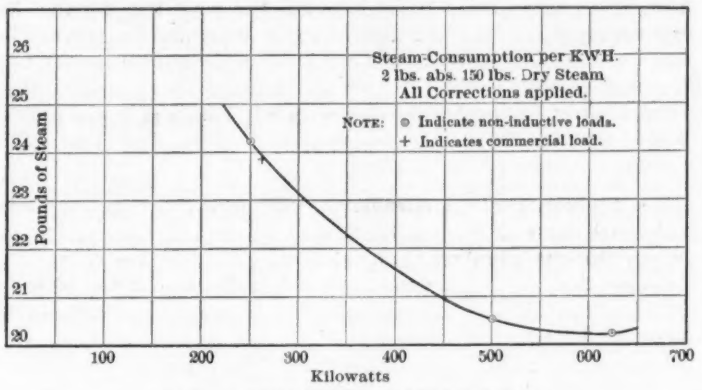


FIG. 1.—CURVE OF STEAM CONSUMPTION.

to the step in case the pumps give out. The top oil bearing is furnished with oil by a gravity system.

The test was very thorough, including an analysis of the coal and determination of the quality of steam by means of a calorimeter. All water and coal were weighed on platform scales that had been calibrated. All the electrical instruments were calibrated in the Chicago Laboratory of the General Electric Company, and the steam gauges were tested with a Crosby dead weight tester. The non-inductive loads were obtained artificially by the immension of three sheets of metal in a river which runs by the power house. By means of a rope and pulley each sheet could be readily manipulated so as to keep the load at a certain point.

A run designated as the commercial run, condensing, was conducted over twelve hours, during which nothing was operated in the

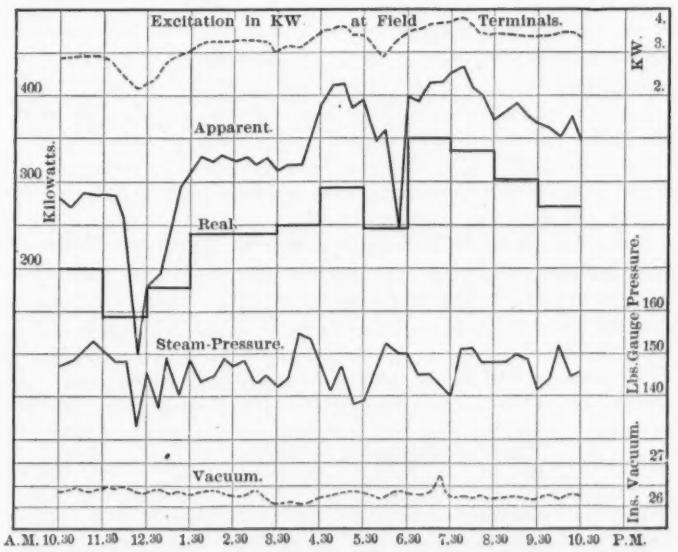


FIG. 2.—CURVES OF COMMERCIAL TEST.

station except the steam turbine unit; the load was varied from a minimum of 144 kw to a maximum of 352 kw, averaging an hour for each of the several stages. The average of the power factor during the run was 77.7 per cent., the minimum power factor being 62.4 per cent. and the maximum power factor 86.8 per cent.

Several runs of four hours each were made under non-inductive loads. Finally a commercial run was made non-condensing extending over a period of three hours.

The commercial runs were made under the station load, and comprised all auxiliaries, including boiler feed pump. After applying all corrections, the data of the tests are as follows:

Commercial run, condensing, average real kw, 262.7; 23.89 pounds of steam per kw-hour. Commercial run, non-condensing, average real kw, 226.5; 58 pounds of steam per kw-hour. Half load, 250 kw, non-inductive run; 24.29 pounds of steam per kw-hour. Full load, 499 kw, non-inductive run; 20.54 pounds of steam per kw-hour. Overload 22 per cent., 611 kw, non-inductive run; 20.19 pounds of steam per kw-hour.

The coal consumption during the commercial run, condensing, was 5.43 pounds per kw-hour, the evaporation per pound of coal being 6.23 pounds of water.

On the commercial condensing run the total steam consumption, including all auxiliaries and boiler feed pump, was 31.7 pounds per kw-hour after applying the necessary corrections.

Temperature Limits for Electrical Machinery.

Our London contemporary, the *Electrical Review,* discusses as follows a report by the Sub-committee on Physical Standards of the Engineering Standards Committee on the temperature experiments which have been carried out by Mr. Rayner under the direction of Dr. Glazebrook, at the National Physical Laboratory:

The report constitutes a very interesting and valuable record of the investigations in question. One remarkable feature constantly in evidence, which we feel bound to criticise, is that, from a reading of the report, the impression is conveyed in many cases that certain important phenomena have on this occasion been observed for the first time. The only allusion to the work of others is a reference to a paper by Brown, entitled, "The Rise of Temperature in the Field Coils of Dynamos" (*Proceeding of the Institution of Electrical Engineers,* Vol. XXX. (1901), p. 1159). It is far from our intention to depreciate the present very careful, painstaking and interesting investigation, but in view of information which had already been published several years ago, and which leads to substantially the same conclusions as have been arrived at by this later investigation, we do not see the necessity for having delayed the recommendations concerning the standardization of the temperature rise, pending the completion of these tests.

As stated in the report, the permissible temperature of field spools is dependent mainly upon the properties of the cotton coverings of the copper conductors. The tests regarding this point led to the conclusion that a temperature of 125° C. could not be exceeded without the risk of impairing the insulation of these cotton coverings, and that this limit was only safe in cases where the moisture had been completely and finally expelled from the cotton coverings; for when even slight traces of moisture are present, a serious leakage may occur, since the ohmic insulation resistance of many *dry* insulations is halved for, say, every 7° C. increase in temperature. Hence with 80° to 100° C. increase in temperature, the ohmic insulation resistance is but a small fraction of the value at, say, 30° C. If even a slight trace of moisture is present, the insulation resistance is again reduced many-fold. It is pointed out in the report that the weight of the cotton covering often comprises some 5 per cent. to 7 per cent. of moisture, which may be expelled by heating.

Everything mentioned up to this stage has already been pointed out years ago by others. One point on which we do not remember to have seen any experimental results, relates to a quantitative investigation of the rate at which the insulation resistance of a cotton covering varies with the percentage of contained moisture. The results could be expressed in terms of the percentag reduction in insulation resistance for 1 per cent. increase in moisture in the cotton covering. We suggest that this would be a useful and original subject for investigation, and we believe that the nature of the results would be such as to lead to the far more general use of vacuum ovens in the electrical industry.

Vacuum ovens are not even so much as mentioned in the report, although we find occasional reference to the set-backs in the work due to a tardy discovery that the omission of sufficient preliminary "stoving" necessitated a repetition of tests. The report also takes due note of the fact that cotton coverings from which moisture has been carefully expelled rapidly take up from the surrounding atmosphere some 4 per cent. to 7 per cent. of their weight in moisture. This should lead to a careful consideration of the question not only of impregnating the insulations with some suitable varnish, but also

of filling up all interstices between conductors, with some suitable insulating compound. This may be done by thoroughly exhausting the air from the coil in a vacuum chamber, and then filling it in solid under pressure. Not only will moisture be thus effectively excluded, but, by the right choice of impregnating materials, the emissivity of the coil may be greatly improved. The report describes a field spool which appears to have been treated in substantially this manner, in which a decrease of over 25 per cent. in the temperature rise of the coil was thus attained. There are on the market several materials for such a purpose, and it would be of interest to have comparative tests of the results obtained by impregnating otherwise identical coils with these various materials.

A large part of the report is devoted to a description of an investigation in which, for nine different designs of field coils supplied by several manufacturers of electrical machinery, observations were made of the percentage by which the maximum temperature in the interior of the coil, as determined by thermo-junctions, exceeded the temperature as obtained by resistance measurements. The excess was found to amount to over 15 per cent. in a good many instances.

At this point we must revert to the subject of cotton coverings, and call attention to the results of Dettmar's* investigations, completed in 1900, on the effect of temperature on the cotton coverings of copper wires. Dettmar made a series of deterioration tests at 95° C., withdrawing and testing numbers of samples at pre-arranged intervals. After 100 hours, no change in the cotton covering was observable. After 500 hours, a slight discoloration was apparent, and a decrease in the flexibility could be observed in the cotton covering on bending the wire sharply. After 1,000 hours, the discoloration and the decrease in flexibility were more pronounced. Dettmar concluded that while 95° C., or even more, may be permissible for stationary windings, it should be regarded as the extreme upper limit for windings subject to vibration, such as occur in the coils on rotating armatures. Similar tests at 115° C., also for 100, 500 and 1,000 hours, resulted in such pronounced deterioration as to lead to the conclusion that so high a temperature should not be permitted. Another group of tests with paper-insulated wires showed that in that case a temperature of 115° C. could be permitted with perfect safety.

In view of Dettmar's tests, which are accepted as authoritative by the German Association of Electrical Engineers, it would hardly be conservative to assign to the highest temperature, to which there should be any probability that the cotton coverings of the turns of the field magnet windings would be exposed, any value higher than 100° C. Taking this figure, then the highest value of the temperature, as determined by measurements of the resistance of the coils, should not be permitted to exceed 87° C. Electrical machinery is often required to operate in places where the surrounding temperature permanently or occasionally reaches 35° C. Hence there remains 52° C. as the highest permissible temperature increase as determined by measurement of the increase of resistance, if we wish by means of a general rule to ensure that the quality of the cotton coverings shall not be impaired by the temperature to which they are exposed. This final deduction is our own, and it may be useful to go on with, pending the issue of an authoritative recommendation from the Standardizing Committee.

As to thermometric measurement of the temperature of field coils, we thoroughly agree with the position taken up in the report, that this method should make way for the more exact method by means of resistance measurement. One finds, however, from the National Physical Laboratory tests on these nine coils, an average value for the temperature, as thermometrically determined, of less than 65 per cent. of the value determined by measuremnt of the electrical resistance, and hense, in cases where thermometric measurements are employed, a temperature rise of more than 35° C. above the surrounding air could not consistently be permitted.

It will be interesting to see how it is proposed to square these facts with the intimation contained in the interim report of the subcommittee, to the effect that the temperature limits ultimately to be recommended are likely to be more liberal than those laid down by either the American or German Electrical Standardization Committees. It has always seemed to us that apparatus of continental manufacture is rated decidedly too high as regards the temperature rise permitted, although we admit that the high output obtained per unit of weight is in great part legitimately obtained by the excellence of the designs as regards ventilation.

*"Ueber die Nothwendigkeit der Aufstellung von Normen für die Bestimmung und Angabe von Leistung, Erwärmung und Wirkungsgrad elektrischer Maschinen."—Georg Dettmar, *Elektrotech. Zeitschr.* Vol. xxi., August 23rd, 1900, p. 727.

Acceleration Tests of Electric Locomotive.

The results of a series of tests conducted by the New York Central & Hudson River Railroad and the General Electric Company on a "Pacific" type of steam locomotive and an electric locomotive having practically the same weight on the drivers are very interesting as illustrating the marked superiority in acceleration of the electric over the steam machine. The run was made on April 29. Each locomotive was required to haul a six-car train, the total train weight being 487.5 tons for the steam locomotive and 427 tons for the electric locomotive. The line electromotive force during acceleration was 680 volts for the series and the series multiple positions and 515 for the multiple position of the controller. These conditions of voltage were as nearly as possible what will obtain in actual practice within the electric zone in the neighborhood of New York. The tabulated resudts are as follows:

	Steam.	Electric.	Difference in favor of electric.
Length over all	67 ft. 7¾ ins.	36 ft. 11¼ ins.	30 ft. 8½ ins.
Total weight (including tender for steam locomotive)	342,000 lbs.	200,500 lbs.	141,500 lbs.
Concentrated weight on each driving axle	47,000 lbs.	35,500 lbs.	11,500 lbs.
Revenue bearing load back of locomotive ...	256 tons	307.25 tons	51.25 tons
Acceleration m. p. h. p. s. averaging up to 50 m. p. h.	.246	.394	.148
Time required to reach speed of 50 m. p. h. ..	203 sec.	127 sec.	76 sec.

The electric locomotive from the first turn of the wheels accelerated faster than the steam locomotive, and, at a distance of 1,500 ft. from the starting point, the electric locomotive led by a train length. At all speeds the smooth riding qualities of the electric locomotive were very noticeable. The tests were supervised for the New York Central by Messrs. W. J. Wilgus and E. B. Katte, and for the General Electric Company by Messrs. E. W. Rice, Jr., W. B. Potter and A. F. Batchelder.

CURRENT NEWS AND NOTES.

SWATTED BY WIRELESS.—Last week a lawyer appeared before a New York City court asking that summonses be issued to Prof. M. I. Pupin and Prof. C. F. Chandler, of Columbia University, on the ground that a client had a hallucination that these gentlemen intended to do him bodily harm. Prof. Chandler appeared in the court on Tuesday, but Dr. Pupin sent word that he was too busily engaged in a delicate electrical experiment to attend. The man for whom the summonses were issued stated that he had received several severe beatings of wireless telegraphy which made him pretty sore. "One night I got pummeled so badly in bed that I couldn't get up the next day. I had no idea who was assaulting me until one day I got a wireless message telling me that it was Profs. Pupin and Chandler. I never met these gentlemen, but I want them to deny it in court." The case was dismissed.

MR. JOHN GAVEY, C. B., engineer-in-chief of the technical department of the British post office service, has been elected president of the British Institution of Electrical Engineers. Mr. Gavey has been connected with the telegraph service since 1860, in which year, after graduation at the age of 18 from Victoria College, Jersey, he entered the service of the International Telegraph Company. When the telegraphs were taken over by the state in 1870 he was appointed superintendent of one of the southern divisions of England, and in 1878 became superintending engineer of the South Wales District of Telegraphs. In 1892 he entered the General Post Office, London, as chief technical officer, becoming second assistant engineer-in-chief in 1897, assistant engineer-in-chief and electrician in 1899, and in 1902, on the retirement of Sir William Henry Preece, he became engineer-in-chief. Mr. Gavey erected the first trunk telephone line in England in 1881 and collaborated with Sir William Henry Preece in the experiments made early in the last decade on electrostatic and electromagnetic wireless telephone transmission. He has also done much work in the improvement of telegraph apparatus and circuits.

FIRES FROM ELECTRICITY.—The Continental Insurance Company has tabulated the number of fires and their causes in connection with claims paid by that company during the period 1899 to 1904. Those having their cause in lighting formed 14.33 per cent. of the total, fires ascribed to electric origin at 2.79 per cent., or almost the same as the figure for spontaneous combustion, which is 2.58 per cent. The number of fires from lightning were 7 per cent. of the total.

AMERICAN CHAMBER OF COMMERCE IN ITALY.—Mr. J. P. Spanier, president of the American Chamber of Commerce, 10 Piazza della Borsa, Naples, Italy, notifies us of the establishment of this institution. It embraces among its members some of the largest firms in Italy and America, and everything possible will be done to facilitate business relations between the two countries. A larger membership is desired. This institution no doubt will open up the way for the expansion of commerce between Italy and the United States.

UNITED STATES NAVAL WIRELESS.—Interesting reports are made of communications had between the vessels at sea with wireless telegraphy during the recent cruise of United States battleships. While proceeding north from the target field and when about seventy miles southeast of Cape Hatteras, a wireless message was received from the battleship *Illinois,* which was outside the Virginia capes with the *Marcellus* testing a coaling device, and a considerable conversation ensued. The distance was about 160 miles. At the close of the race of the big battleships, the *Missouri,* although beyond ordinary signaling distance, was readily communicated with by wireless.

CHICAGO LIGHTING RATES.—Gov. Deneen's signature is lacking to the bill giving the Chicago City Council the right to fix gas and electric light charges within the boundaries of the municipality. The House has concurred in the Senate amendment to the bill and it now goes to the Governor, whose signature is a foregone conclusion. The measure passed both branches of the Legislature without a dissenting vote. The new bill is a "double-header." It not only provides that the Chicago City Council may fix the price of gas, but that the city may sell its surplus electric power to private consumers. The law must be voted upon by the people of Chicago before taking effect, and will be submitted to popular vote or referendum this fall.

GASOLINE MOTOR CAR FOR RAILROADS.—It is stated in a Chicago dispatch that a gasoline motor car is being developed by the Harriman system to compete with electric roads. Mr. Harriman, it is stated, eight months ago saw the necessity of having on steam railroads a car driven by some other power than steam to compete with electric lines mainly, and also to save the expense of operating trains drawn by steam engines carrying passengers over branch lines, and for light suburban service. The motor car will make a trip from the Pacific to the Atlantic Ocean. It will go from Omaha to Portland, and, after being exhibited for a few days at the exposition there, will start on its transcontinental trip. In last week's issue we referred to the investigation into the operation of this car by the officials of the Illinois Central Railroad.

WIRELESS WEATHER REPORTS.—It is stated from Washington that the Government wireless telegraph stations will shortly extend in a chain along the Atlantic coast from Portland, Me., to Galveston, Texas. It has been arranged by the Navy Department that all merchant ships fitted with wireless apparatus shall make daily weather reports when in touch with the Government stations which are now established between Portland and New Orleans. All such reports will be forwarded to the Weather Bureau at Washington. It is also planned that there shall be special reports of any marked changes observed in the barometer at other times. These naval wireless stations will furnish the ships when desired with weather forecasts which come from the Weather Bureau. At certain of the posts the usual weather signals will be displayed, those posts being selected from which the signals may be best observed by passing vessels.

SPECIAL TRAIN TO DENVER.—Arrangements have been made by the National Electric Light Association to run a special train of Pullman cars from New York to Denver via Pennsylvania line and Burlington route, leaving New York Saturday, June 3, and arriving at Denver Monday, June 5. This train will be a duplicate of the Pennsylvania Limited. Electrically lighted, parlor, smoker, dining and observation cars will be run via Chicago, at which point the train will be consolidated with a similar train, none being made up for the accommodation of Western delegates. Application for space should be made early, as the lower berths are limited in number. Application should be made to Mr. George F. Porter, master of transportation, 136 Liberty Street, New York City, or to Mr. Colin Studds, Eastern passenger agent Pennsylvania Railroad, No. 263 Fifth Avenue, New York City.

RÖNTGEN RAY CONGRESS.—The international congress held in Berlin to celebrate the tenth anniversary of the discovery of the Röntgen ray closed May 3. The discussions, according to a dispatch, turned largely upon cancer treatment. The final resolution declared that the rays ought not to be employed except by thoroughly qualified practitioners. Prof. Lassar, an eminent dermatologist, premising that the rays ought not to be applied except in serious cases because of their dangerous properties, strongly urged that they are superior to the knife in removing cancerous growths. A few years ago, he said, the imagination did not dream of the success that could be achieved by the use of the rays in cases of gangrenous cancer. He had had only three failures in a hundred cases. Nevertheless, the rays were of little use in removing large tumors, their penetrative powers only extending half a centimeter. Wherever there is great suffering he urged the application of the rays because of the relief they give from pain.

STARTER FOR INDUCTION MOTORS.—A patent granted May 2, 1905, to J. H. B. Bryan relates to a device by means of which the auxiliary starting resistance in the secondary circuit of an induction motor may be automatically and gradually thrown into and out of operation upon stopping and starting the motor. The starting resistance is provided with a switch whereby more or less of the resistance may be included in the secondary circuit. This switch is connected directly to a piston which is operated in a suitable cylinder by means of compressed air. When air under pressure is admitted to one end of the cylinder, the air in the other end is allowed to escape very slowly, so that the cylinder acts like a dash-pot in retarding the motion of the piston. The act of opening or closing the switch in the main power circuits to the motor, by means of a system of levers, simultaneously admits air to the proper end of the cylinder referred to above. From what source the compressed air is to be obtained is not stated in the specifications.

THE ELECTRIC LOCOMOTIVE.—In an able editorial discussion of the electric locomotive, the *Railroad Gazette* says: "Twenty years ago there was not a single electric railroad in successful operation in the world, nor were there many steam locomotives of more than half the weight of these electric engines projected for the Pennsylvania. Now, it is suggested, and the suggestion is acted upon with the expectation and certainty of a successful outcome, that the traffic of two of the great railroads of the world into the largest city in the country shall be handled by a means of locomotion that is not yet of age. Surely, we are moving and moving rapidly when such a state of affairs can be developed from nothing in so short a time; and the significance of it all is emphasized by the fact that millions of dollars are invested in the firm conviction of satisfactory results. In this development we have been remarkably free from freak work, which has undoubtedly been a notable advantage in training the investor to look at the schemes suggested with confidence that they can be executed. Had there been a series of failures in electric locomotive work, even though the initiated might have known the result in advance, it would probably have had its effect upon the public and the railroad manager. But the work that has been done along these lines has been in the hands of experts, and there are no records of glaring failures in public, though it would be more than human had there not been trouble and to spare. The situation to-day, however, appears to be clear, and it is evident that the electric locomotive has taken its place in the railroad service of the country. It is but natural to look for a rapid multiplication of the places where it will be applied."

TELEPHONE TAXIMETER.—A cable dispatch from Paris gives as follows what appears to be a description of the familiar American calculagraph: "The Paris telephone administration has just introduced into its public offices a register with a clock face—like the taximeter—the circumference whereof indicates twelve minutes, divided into units of conversation periods, namely, three, six and nine minutes. When the machine is set going the person using the telephone can see precisely how long he has been speaking."

DR. ERNEST FOX NICHOLS, professor of experimental physics in Columbia University, has been appointed to be the first incumbent of the Ernest Kempton Adams Research Fellowship of $50,000. Prof. Nichols is spending this year with Prof. J. J. Thomson in the Cavendish Laboratory at the University of Cambridge, and has nearly completed some important researches which will be brought to a conclusion during his incumbency of the Adams Fellowship, and published as the first contribution from that admirable foundation, which provides for the publication of the results of researches.

INSTITUTE ANNUAL MEETING.—The 197th and annual meeting of the American Institute of Electrical Engineers will be held in the chapter room of Carnegie Hall, 154 West Fifty-seventh Street, on Tuesday, May 16, at 8.15 p.m. The result of the recent election for officers of the Institute will be announced, and the secretary and treasurer will present their annual reports. The following papers will then be presented and discussed: "Time-Limit Relays," by George F. Chellis, associate A. I. E. E., Interborough Rapid Transit Company, New York. "The Proper Limit of Duplication to Secure Reliability of Service," by H. W. Buck, member A. I. E. E., Niagara Falls Power Company, Niagara Falls.

LODGE ON LIFE.—In the May number of the *North American Review* Sir Oliver Lodge discusses the question, "What is Life?" Beginning with an examination of certain recent views in chemistry as to the manner in which atoms of various substances group themselves, and pointing out that fresh qualities are liable to be introduced as the groupings grow larger and become more complex, he inquires what new property may be expected of a compound containing billions of atoms attached to each other, not in a rigid manner, but by loose, unstable links. Such compounds are able constantly to rearrange themselves. Sir Oliver confesses that we could not guess what would happen in compounds of this kind, but we have a concrete answer to the question in the physiological development and structure of man. The cell possesses the power of uniting with other cells, and it absorbs into its own substance such portions as may be suitable, and rejects the unsuitable; thus begins the act of feeding. Such a cell, again, is split into two or more new cells, which separate and continue independent existence; thus begins the act of reproduction. In the same way Sir Oliver traces the development of the various functions of the perfected aggregation of the human body. This complex molecular aggregate is capable of being the vehicle of life, but we have as yet no answer to the question what life itself is. All efforts to generate life have been failures, and Sir Oliver dissents from those who regard life as being generated from matter by any such process as he has described. He regards it rather as a contact between the material frame of things and a universe higher and other than anything known to our senses. The startling versatility of Sir Oliver in speculation should merit him a call from Chicago University.

Electrical Engineers of the Times.—IX.

MR. JOHN BALCH BLOOD.

Mr. John Balch Blood, who was born in Newburyport, Mass., July 21, 1870, was graduated from the Massachusetts Institute of Technology in 1890 with the degree of S.B. in the course in electrical engineering. Upon graduation he went with the Thomson-Houston Electric Company, of Lynn, Mass., and there entered the railway engineering department. As assistant engineer of this department, he had charge of the design of railway motors and designed the various sizes of street railway motors in use at the time, and the motors which were used on the Intramural Railway at the World's Fair, Chicago, 1893. He also worked out and drew up the original propositions that were presented by the Thomson-Houston company to the Central London Railway, the Manhattan Elevated Railway, N. Y., the underground railways in Paris and the Baltimore & Ohio Railroad for its terminal in Baltimore. When the General Electric Company was formed he held the same relative position as assistant engineer of the railway department, with offices in Schenectady, N. Y. In this position he continued in charge of the design of railway motors and the applications of the same.

In 1896 Mr. Blood entered the employ of the Union Elektricitäts Gesellschaft, Berlin, Germany. Here he had to do with the various engineering projects then in hand in the several European countries He took up there a special equipment for the Oberschlesischer Kleinbahn and designed a special motor for it, and designed a motor for elevated railway service on the Berlin elevated railways, then contemplated, and the elevated railway in Vienna. Among other projects was a mountain rack railway at Linz and a proposition for the electrical equipment of the railway over the pass at Goldau, Switzerland. He also had charge of the design of railway motors.

In 1897 he returned to this country and formed a partnership with Mr. Joshua Hale under the name of Blood & Hale, with headquarters in Boston, as consulting engineers. As consulting engineers, the firm did considerable work for the Lake Street Elevated Railway in Chicago, in the redesign of its equipment. They were retained as engineers by the Lorain Steel Company, motor department, and as such designed the complete output of this company in its motor department. This department placed on the market a complete line

MR. JOHN BALCH BLOOD.

of railway equipments, both for street service and for heavy electric traction. In 1898 Mr. Blood made a trip to Europe, primarily with reference to an electric railway proposition at Oran, Algeria. He visited Stockholm in connection with a competitive project on some engineering changes in the government railway system there, and took up in Moscow some Russian railway projects.

Messrs. Blood & Hale developed three distinct systems of multiple-unit control for heavy electric traction, which they sold to the Sprague Electric Company in 1902. Since that time they have been retained as consulting engineers on the matter of train control. Among other projects, they have engineered, constructed and are now operating the Mississippi Valley Traction Company, an interurban railway in Illinois. They have done considerable work in the line of power stations for mills, and were retained as consulting engineers for this purpose by Lockwood, Greene & Co.

Mr. Blood has acted as expert in a number of important causes. He was retained by the Boston Gas Company in the subway explosion cases and was called in a case before the highest court of the province of New Brunswick. Mr. Blood is a registered patent attorney, and has had much to do with patents as an expert and as an inventor, along the lines of his professional work. He has given a course of lectures on alternating-current machine design, to the senior class of Massachusetts Institute of Technology for the last four or five years.

Mr. Blood is a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the Boston Society of Civil Engineers and the New England Street Railway Club. He has given the matter of the application of power to heavy electric traction much consideration, and presented a paper at the 1903 meeting of the American Society of Mechanical Engineers, entitled, "A Rational Train Resistance Formula."

Underground Electric Conduit System in New Orleans.

THE New Orleans Railway Company, of New Orleans, La., recently secured from the city a contract which provided for the street lighting for a period of ten years, from September, 1905, with the condition that all wires within a certain district should be placed in underground ducts. The extensive system designed to carry out this provision is now nearing completion. In addition to the cables for serving arc lamps, the conduit system is designed to receive the conductors for all the commercial electric light and power service in the "underground district," as well as the main trunk cables, which will be employed to interconnect the various power stations.

The character of the soil, the drainage system and the climatic conditions in New Orleans are such that the successful installation and operation of a conduit system require special design and unusual care in construction. The temperature varies from 25 degs. F. on rare occasions in winter to 95 degs. F. as a maximum in summer. The average annual rainfall is 51.5 in., a large relative proportion of which falls in January, February, July and August, the average fall being 5.7 in. in Februry and 6.2 in. in July. Heavy showers are frequent, the records of the weather bureau showing a fall of over 9 in. in 24 hours, and of 5.75 in. in 2 hours on March 14, 1903. This latter was one of the heaviest storms on record.

The average elevation of the city is about that of the normal river level, the streets being highest at the river front and sloping gradually back to Lake Pontchartrain, which is also lower than the river. At times of high river, the entire city would be submerged were it not for the system of levees. The relative elevations are illustrated by a vertical section through the main portion of the city, as shown to the left in Fig. 1.

All of the liquid wastes of the city, as well as all rainwater falling within this area, must flow towards and be discharged into Lake Pontchartrain. The normal grade is so slight that the flow would be very slow without the artificial drainage and sewerage system. The drainage system is designed to receive only the surface waters. It consists of sewers, which are laid just below the street levels, and which discharge into a system of canals, the water from which is elevated by pumping stations to a height sufficient to provide the grade necessary for the rapid flow of the water to the lake. The sewerage system is entirely distinct from, but is, in general, similar to the drainage system, except that it is much deeper below the city streets, and is of considerably less capacity.

The alluvial soil, upon which New Orleans is built, consists of fine silt, and the elevation above the river is such as to produce conditions which render difficult the maintenance of a water-tight conduit system. It was particularly desirable to make the conduit system water-tight in order to obtain the right to drain into the city sewerage system, so as thereby to eliminate the necessity for the pumping out of all waters which might seep into the ducts or manholes.

The ditching is, as a rule, easy, the soil being handled without the use of picks. In rainy weather, or when the earth is wet, it becomes very sticky, and the shovels must be dipped into water after handling each shovelful of dirt. Ditches vary from 16 in. wide by 24 in. deep to 48 in. wide by 8 ft. deep, depending upon the number of ducts to be installed, and upon the location and nature of the obstructions which are encountered.

After the trenches are excavated to the grade, they are lined on both sides with pecky cypress lumber. The earth is then rammed tight between this boxing and the side of the ditch, which acts as a bracing. When the ditch exceeds 3 ft. in depth, additional bracing is generally necessary near the surface, and, in some instances, it was found necessary to close-sheet the ditches for their entire depth.

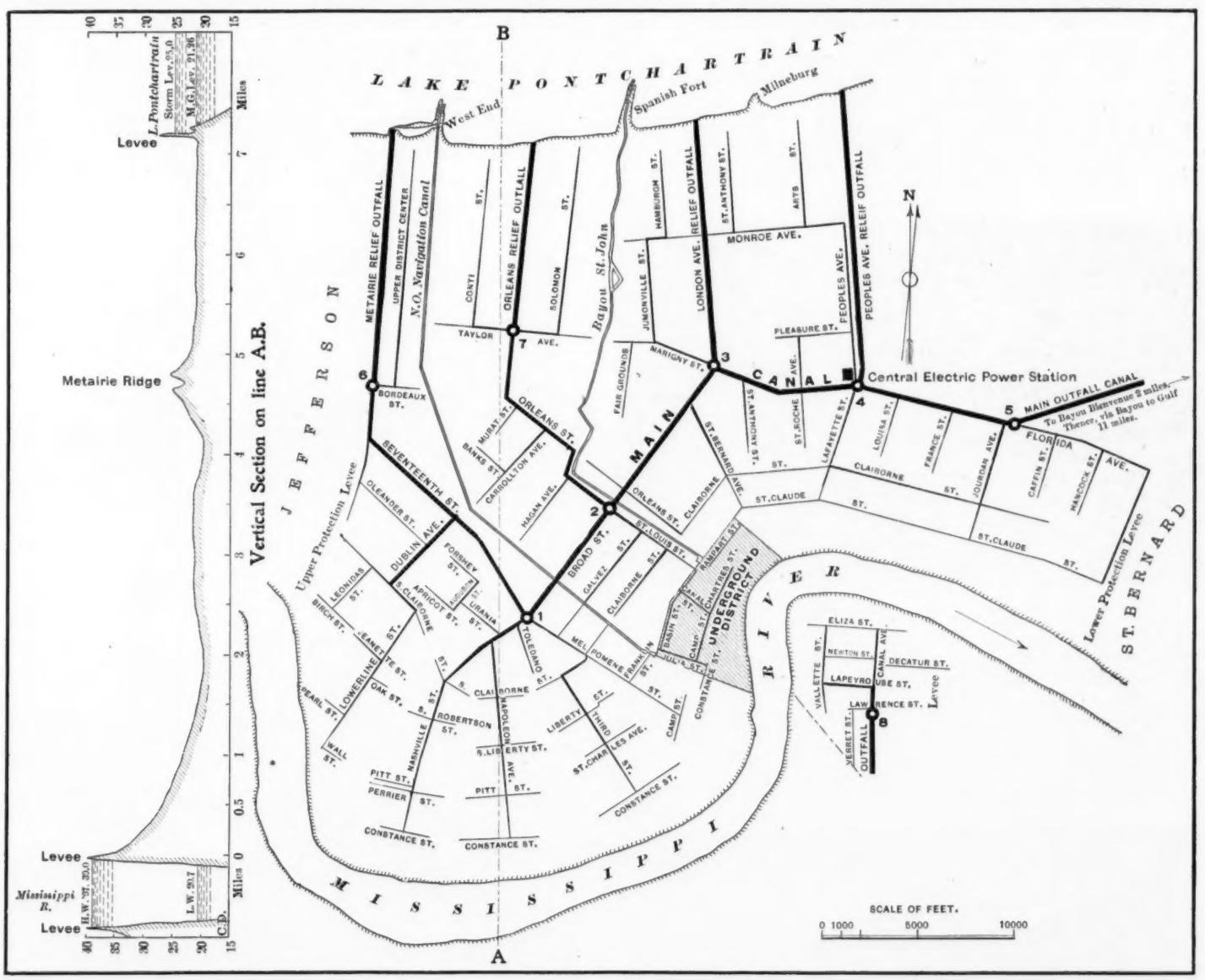


FIG. 1.—MAP OF NEW ORLEANS, SHOWING DRAINAGE SYSTEM.

About 4 inches of concrete is laid in the boxes before the ducts are placed in position.

FIG. 2.—DROMEDARY CONCRETE MIXER.

The concrete used is made from Atlas portland cement and bar gravel which would pass through a ¾-in. screen, the mixture being in the ratio of 1 of cement to 6 of gravel. This is practically equivalent to 1:2.5:3.5 mixture. When practicable, all concrete is prepared with a dromedary mixer, illustrated in Fig. 2. It is made very wet so that it will readily flow between the ducts. The concrete

FIG. 3.—DUCTS BEING LAID.

wall at the side of the ducts is maintained at about 4 in., with the same amount on top, over which 1-in. pecky cypress planks are laid as an additional protection from external damage. This covering and the trench boxes, previously mentioned, will, it is believed, be preserved perfectly in the New Orleans soil. The method of laying the ducts may be seen from Fig. 3.

The ducts, which were furnished by the Fibre Conduit Company,

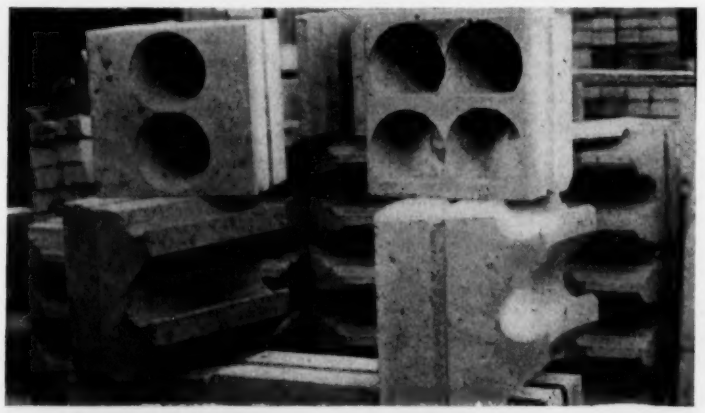


FIG. 4.—CONCRETE BLOCKS FOR MANHOLES.

of Orangeburg, N. Y., possessed for this work the following advantageous characteristics: A light single tube on which freight and handling were reduced to a minimum; a conduit subject to the least possible electrolytic action; a practically continuous water-tight tube as laid.

The slope of the conduit as laid is not less than 4 in. to 100 ft., which will give the necessary drainage for any small amount of

FIG. 5.—MANHOLE PARTLY COMPLETED.

water that may get into the ducts. The male ends of the ducts are dipped in compound before feeding, and then are wrapped at the

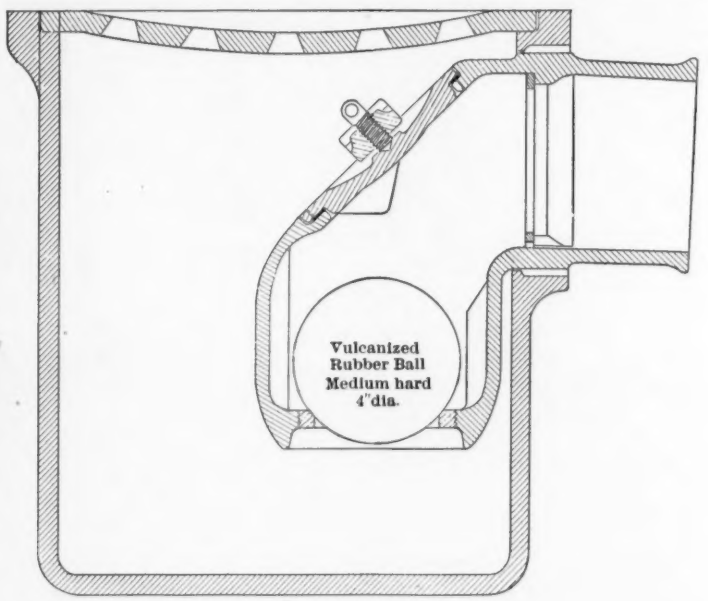


FIG. 6.—TRAP FOR DRAINING MANHOLE.

joint with a strip of duct also dipped in the compound. This makes an absolutely water-tight joint.

All manholes are built of specially moulded concrete blocks, the design of which permits manholes of any depth or size to be constructed from the standard shapes. Some of the blocks have moulded on them a bridging shelf, which acts as a cable rack. This has the advantage of acting as a barrier between cables at different

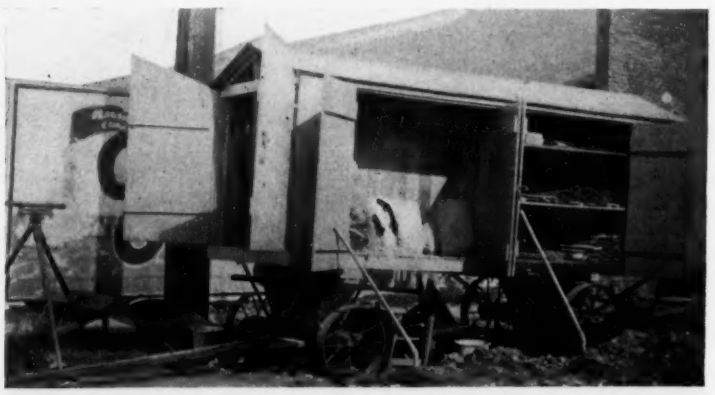


FIG. 7.—TOOL WAGON.

levels, and does away with the necessity of driving any metal hooks into the walls of the manholes for supporting cables. Different styles of blocks are shown in Fig. 4, and one of the manholes is illustrated in Fig. 5.

The manholes are built on concrete bottoms 6 in. to 8 in. thick,

and the blocks are laid by an ordinary mason with a helper. A mortar setting of one part cement and two parts sand is used to point the joints. Twisted Ransome rods or wires are inserted in the vertical grooves in the sides of the blocks, and the grooves are then grouted full of very thin mortar made of one part cement and two parts fine, sharp sand. The manholes are covered with reinforced concrete tops except in special cases or in shallow manholes where cast-iron covers alone are used.

The surface water which flows into the manholes is drained wherever possible into a sewer system through a combined trap and check valve, shown in Fig. 6, which was designed especially for this purpose. The water from the manhole can pass readily to the sewer, but, if the latter backs up, the trap is automatically closed and the water cannot enter the manhole. By removing one thumbscrew and lifting the grating of the internal cover, the trap can be cleaned from all obstructions by the use of long rods when it has been found to be clogged. These traps have proved entirely satisfactory for this system.

The streets of New Orleans are paved with ballast blocks, asphalt, cobble and macadam. By far the largest portion is of the ballast form, the blocks being of granite and averaging about 12 by 18 by 12 inches. These are very heavy, two men being required to handle each stone. The resulting pavement, even when carefully laid, presents a very rough surface. The best results with any type of pavement are obtained by covering the entire graded surface with 2-in. pecky-cyprus planking laid about 4 in. below the bottom of the pavement. This is covered with a sand cushion from one to inches thick upon which the paving is placed. For asphalt or macadam,

FIG. 8.—ELECTRIC PUMP WAGON.

the sand cushion is omitted, and in some cases a concrete foundation is laid.

Experience in New Orleans has demonstrated that, in order to maintain street railway tracks in good operating condition, the entire roadbed must be supported upon a continuous planked bottom which carries the ballast and ties. The equipment employed in this construction is illustrated in Fig. 7, which shows a tool wagon containing a set of ditching tools as furnished to each gang.

A most useful outfit is illustrated in Fig. 8, which shows an electric pump mounted on a wagon, which was used for removing water from the trenches. It was most successful in keeping out the water at a minimum expense. The car lines in New Orleans, which are upon almost every street, furnished a ready means of securing power for the operation of the direct-current motor which drives the pump.

The work described was, of necessity, carried on with greatest possible speed, and in order to avoid having too much street torn up at any one time, numerous gangs were used, each being employed upon a sub-division of the work. A typical case is as follows: One gang to lift the paving and stack it up; a ditching gang who removed the earth and put in the bracing; a conduit gang who placed conduit and concrete, followed by a gang to restore the earth and then by the paving gang. After each gang had become thoroughly familiar with its particular duty, the progress of the work was greatly facilitated.

The final disposal of the material which had been taken from the ditches was particularly difficult, owing both to the distance to which it had to be carried and to the difficulty of handling it. On account of the distances to be covered and the necessity for constant inspection, it was found desirable to mount on horseback all those employed in a general supervisory capacity.

The entire construction was designed and installed by Sanderson & Porter, of New York.

Calculation of Pull Due to Solenoids.

BY CHARLES R. UNDERHILL.

IN order to obtain data from which to design solenoids for the coil-and-plunger type of electromagnet, the writer made tests of coils and plungers of various dimensions which were described in a previous article.*

The result of the tests is shown in Fig. 1, which indicates the maximum pull due to solenoids of different lengths with varying magnetizing forces, and for one square inch of plunger. In this particular case each winding was 3⅛ in. in external diameter.

The curve in Fig. 2 is plotted from the curves in Fig. 1, and shows

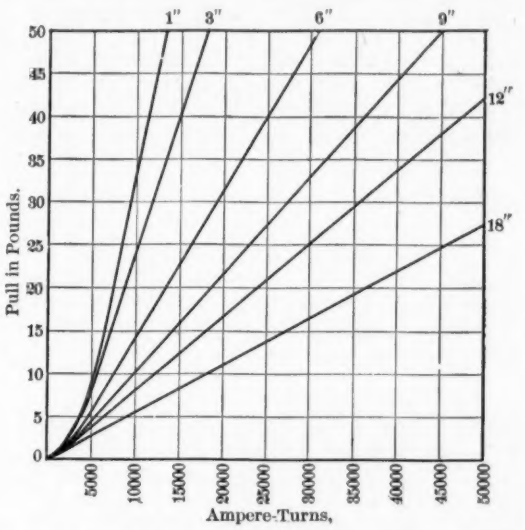


FIG. 1.—PULL DUE TO SOLENOIDS OF DIFFERENT LENGTHS WITH PLUNGER 1 SQ. IN. IN CROSS-SECTION.

the relation between the maximum attraction in pounds, for each 10,000 ampere-turns, and each square inch of cross-section of plunger, and the length of the solenoid in inches.

By referring to Fig. 1 it will be observed that the pull is directly proportional to the ampere-turns after a certain point. This means that a certain amount of m.m.f. is required to saturate the iron core, after which the flux in the core is practically constant regardless of the magnetizing force. This has the effect of making the

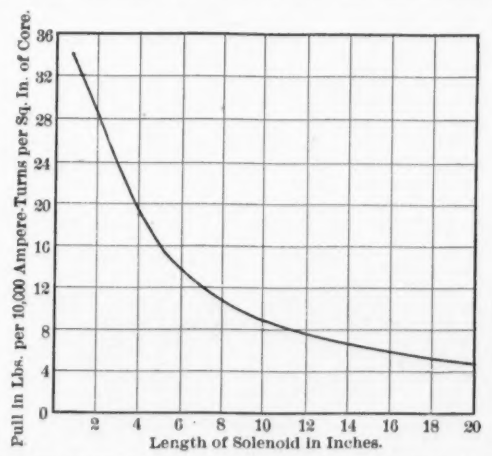


FIG. 2.—CURVE SHOWING RELATION BETWEEN LENGTH OF SOLENOID AND PULL.

pull above this point directly proportional to the ampere-turns, or magnetizing force, since the pull is proportional to the product of the magnetizing force in the coil, and the flux in the iron core or plunger.

The general construction of the solenoid may vary with the ideas of the designer, but the length of the winding and the diameter of the core or plunger are all important, and it must be remembered that the strength of a solenoid is limited by the electrical carrying capacity of the winding.

As the total work obtained from any long solenoid is practically constant, regardless of its actual length, for the same ampere-turns,

*ELECTRICAL WORLD AND ENGINEER, April 29, 1905.

the pull for any length of solenoid is proportional to the ampere-turns per inch. Therefore an 18-in. solenoid will pull practically the same as a 9-in. solenoid if twice the energy is applied to the winding.

Fig. 3 shows the product of the pull into the length of the winding. This curve may be called an "inch-pound" curve. The total work due to a solenoid which is great in diameter as compared to its length, is less than that due to a solenoid whose length is great as compared to its diameter, owing to the greater length of the return path of the lines of force outside of the winding, as compared with the length inside of the winding. The theoretical curve is nearly the same as that shown in Fig. 3, which is correct for solenoids 3⅛ in. in diameter. This curve is also correct for sole-

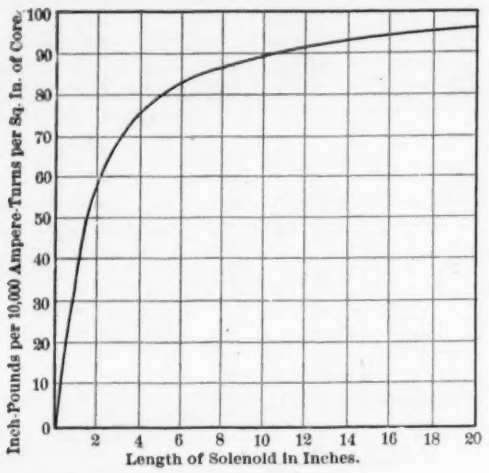


FIG. 3.—PRODUCT OF PULL INTO LENGTH OF SOLENOID.

noids over 10 in. in length, whose diameters do not equal their lengths. An example will be cited presently.

The effective range of a solenoid is the range of action desired, and is measured from the point on the curve where the specified pull starts, to the point where the curve again falls to the specified pull. The pull at the peak of the curve, however, is the pull referred to in all calculations. For instance, if the pull required is 50 pounds, but we wish to increase the range by making the effective greater than the uniform range, the pull at the uniform range or peak must be increased say 10 per cent. in this assumed case, then the

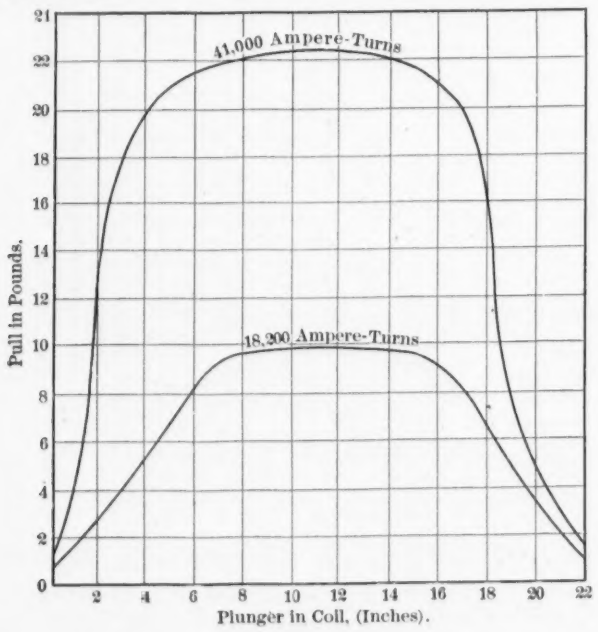


FIG. 4.—FORCE CURVES DUE TO A SOLENOID 18 IN. LONG WITH A PLUNGER 1 SQ. IN. IN CROSS-SECTION AND 36 IN. LONG.

pull, P, upon which we base our calculations, will be $50 \times 1.10 = 55$ pounds.

Fig. 4 shows the curves due to a solenoid 18 in. long and a plunger 36 in. long by 1⅛ in. in diameter. Inspection of these curves indicates that if we deduct 10 per cent. from the peak of the curve, the effective range will be approximately one-half the length of the winding. When the length of the solenoid is referred to, the length of the winding is always meant.

The effective range may be varied at the option of the designer, but this will, of course, change the ratio between the pull at the peak of the curve, and the pull at the start of the effective range. In any case, the given range determines the length of the solenoid.

The diameter of the solenoid will vary with the diameter of the core or plunger, and other conditions such as heating, etc., but a good general rule is to assume a diameter for the solenoid equal to about three times the diameter of the plunger.

An examination of Fig. 1 will show that the ampere-turns per square inch of core should never fall below 10,000, in order to keep the core saturated. Furthermore it is desirable to work the cores of solenoids at high densities because of the relative weight of the plunger necessary when working with lower densities, and the pull per ampere-turn is much less at low densities. If the core was not saturated, the pull would not be directly proportional to the ampere-turns, as the permeability of the iron would be very changeable at low densities.

If we let IN_t = the product of the minimum ampere-turns and the minimum cross-sectional area of the plunger necessary to keep the ampere-turns 10,000 per square inch of core, and if A represents the cross-sectional area of the plunger, then $IN_t = 10{,}000\ A^2$ (1)

whence $A = \sqrt{\frac{IN_t}{10{,}000}} = \frac{\sqrt{IN_t}}{100}$ (2). By this method the amp.-turns will always be 10,000 for each square inch of plunger, which

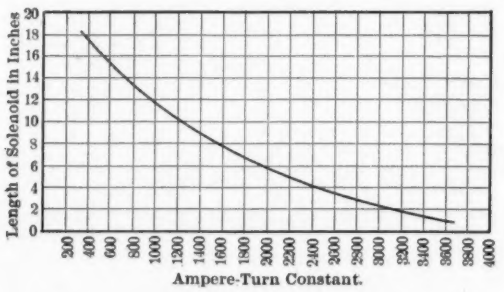


FIG. 5.—AMPERE-TURN CONSTANT CURVE.

insures the minimum expenditure in watts to produce a given result.

Now since $A = d^2_c \times .7854$ (3), the diameter of the plunger dc may be calculated direct by substituting the value of A from (2) in (3), then $IN_t = 6170\ d^4_c$ (4), and $d_c = .1128\ \sqrt[4]{IN_t}$ (5).

The ampere-turns $IN = \frac{IN_t}{A} = 10{,}000\ A$ (6), hence $IN = \frac{6170\ d^4_c}{A}$ (7), or $IN = \frac{6170\ d^4_c}{.7854 d^2_c} = 7854\ d^2_c$ (8), and $d_c = \sqrt{\frac{IN}{7854}}$ (9),

which means, of course, that the ampere-turns will be 10,000 times the cross-sectional area of the plunger.

An inspection of Fig. 1 will show that the straight portion of the lines representing the ratios between pull and ampere-turns for various lengths of solenoids do not point directly to the origin of the lines, but to points at varying distances from the origin. Therefore to be exact in our calculations we must take this factor into consideration, as the ratio between pull and ampere-turns is not a direct ratio, but varies according to the following rule:

$$IN = \frac{10{,}000\ P - n\ (P - Pc)}{Pc} \quad (10)$$

Where P = pull desired, Pc = pull at 10,000 ampere-turns and one square inch of core. n = ampere-turn constant (see Fig. 5).

Consequently

$$P = \frac{Pc\ (IN - n)}{10{,}000 - n} \quad (11)$$

Formulæ (10) and (11) refer to the ampere-turns and pull respectively, for each square inch of core when the core is saturated.

As the usual data given are the pull and the distance, the length of the solenoid having been determined upon, the minimum size of core and the minimum ampere-turns are to be found. Referring to formula (6) we find that for 1 square inch of core, IN ampere-turns will be required. If IN is greater than 10,000 (or enough greater to warrant a core area greater than 1 square inch), we will change IN to INt. Then from (5) $d_c = .1128 \sqrt[4]{INt}$, and since

$$IN = \frac{INt}{A}, \quad IN = 7854\, d^2{}_c.$$

Let us now apply these data to practical design. Take the following example: A solenoid is desired which shall have an effective range of 5 inches, and shall maintain a pull of 30 pounds throughout that range. Allowing 10 per cent. for the difference between the pull at the peak of the curve, and at the start of the effective range, the pull upon which we are to base our calculations will be $30 \times 1.1 = 33$ pounds. The length of the solenoid will then be $5 \times 2 = 10$ inches.

Consulting Fig. 2 it is found that for a 10-in. solenoid, a pull of 9 pounds is obtained for each 10,000 ampere-turns, and each square inch of core.

As the pull is to be 33 pounds, the ampere-turns must be

$$IN = \frac{10{,}000\, P - n\,(P - Pc)}{Pc} \qquad (10)$$

Here $P = 33$, $Pc = 9$, $n = 1240$ (see Fig. 5).

$$IN = \frac{330000 - 1240\,(33 - 9)}{9}$$

$$= \frac{330000 - 29760}{9}$$

$$= \frac{300240}{9} = 33360.$$

Call this INt. $\therefore INt = 33360$.

From (2), $A = \frac{\sqrt{INt}}{100} = \frac{\sqrt{33360}}{100} = \frac{183}{100} = 1.83$.

Then from (6), $IN = \frac{INt}{A} = \frac{33360}{1.83} = 18300$, or $IN = 10{,}000\, A$ $= 18{,}300$, which is the same thing.

To calculate the diameter of the plunger direct, use formula (5), then $d_c = .1128 \sqrt[4]{INt} = .1128 \sqrt[4]{33360} = .1128 \times 13.5 = 1.523$. Therefore the diameter of the plunger would be 1.523 in., and the length of the plunger at least 10 in., say 15 in. in this case. The ampere-turns required have been found to be 18,300.

As in practice the standard stock sizes of iron and steel rod suitable for plungers should be taken; in the solenoid just calculated we should use a plunger 1.5 in. in diameter. Then it is safe to calculate the increase in the ampere-turns, on account of the reduction of the iron, by simple proportion, thus: $\frac{18300}{1.5} = \frac{IN}{1.523}$, hence $IN = \frac{18300 \times 1.523}{1.5} = 18580$.

Any margin of safety desired may be allowed over this, according to conditions.

Fig. 6 is the result of a test of a solenoid 10 in. long, and 8¾ in. in diameter. The winding contained 122 pounds of No. 13 d.c.c. wire. The plunger was 24 in. long and 1⅞ in. in diameter. This test very clearly demonstrates the accuracy of formula (11).

By pointing or tapering the plunger, varying force curves may be obtained, the pull usually being maximum when the pointed end has protruded from the other end of the coil to which it entered. In this case, however, the pull is not so great as with the regular plunger, owing to the diminished cross-sectional area of the iron due to tapering. It is obvious that almost any desired form of force curve may be obtained by giving the plunger peculiar shapes.

The theoretical pull of the solenoid may also be calculated by assuming a value for B, when there are 10,000 ampere-turns per square inch of core, of 225,000. In the English system of units the magnetizing force due to a long solenoid is $H = \frac{3.193\, IN}{L}$ (12), where L is the length of the winding, the value for H being at the centre of the winding.

If now an iron core or plunger, say the same length of the winding, be inserted, it will be drawn inside the winding until the ends of the plunger are flush with the ends of the coil. If now another plunger exactly similar to the first be held near one of the ends of the first plunger, end to end, it will be attracted to the first plunger, and then the two will be drawn inside the winding until the outer ends are equidistant from the ends of the coil, barring friction, of course. This shows plainly that a plunger longer than the winding increases the range of the solenoid.

It has been found mathematically and confirmed by experiment, that the pull required to separate the two plungers under this condition, that is, when the abutting ends are exactly at the centre of the winding, and are perfectly joined magnetically, is directly proportional to the square of the magnetic flux in the iron plungers, and the cross-sectional area of the plungers. In English measure this is expressed by $P = \frac{B^2 A}{72134000}$ (13). Of course, the value of B changes with H, and the permeability of the plunger.

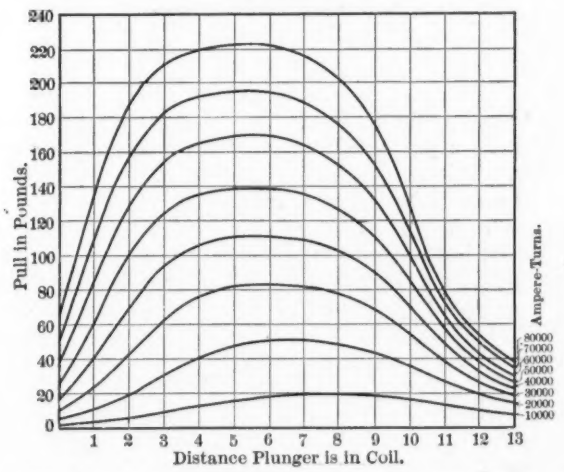


FIG. 6.—FORCE CURVE DUE TO SOLENOID 10 IN. LONG, WITH PLUNGER 2.76 SQ. IN. IN CROSS-SECTION.

Now let us apply this rule to the solenoid, with one regular plunger. When the end of the plunger reaches its position for the maximum pull, the attraction will not be between two parallel faces of iron, or rather the flux in the two pieces of iron, but between the magnetizing force H and the flux B in the iron.

Formula (13) will then be expressed as $P = \frac{BHA}{72134000}$. (14)

Substituting in (14) the value of H from (12),

$$P = \frac{3.193\, I\, N\, B\, A}{72134000\, L}$$

$$= \frac{I\, N\, B\, A}{22600000\, L} \quad (15), \text{ whence}$$

$$B = \frac{22600000\, P\, L}{I\, N\, A} \quad (16).$$

Example: Let $IN = 20{,}000$, $A = 1$, $L = 18$, $P = 10.9$ (see Fig. 1),

$$\text{then } B = \frac{22600000 \times 10.9 \times 18}{20000 \times 1} = 221{,}706.$$

It is evident that there will not be much change in the permeability of the iron for so high a density.

Take another case. Let $IN = 20{,}000$, $A = 1$, $L = 12$, $P = 16.5$ (see Fig. 1).

$$\text{Here } B = \frac{22600000 \times 16.5 \times 12}{20000} = 223{,}740,$$ which is practically the same as in the previous case.

It is here to be observed that for any length of solenoid, the iron is saturated after the ampere-turns per square inch of cross-section of core reach 10,000, although this is slightly less for short solenoids (see Fig. 1).

It is, therefore, evident that the rule $B = \mu H$ does not directly apply to this particular case, as only a section of the core is saturated. That is, since the reluctance of the saturated part of the core is so high, the reluctance of the remaining part of the core need not be considered.

Theft of Current: How to Detect, Prosecute and Prevent.—II.

(Concluded.)

By J. H. Hallberg.

IT must be admitted that there is a tendency with many people to regard it as a pardonable sin to defraud a public-service corporation. This is particularly true when the company gives the customer a favorable opportunity to divert current without much difficulty, and with little or no liability of detection. The keynote to this situation is, therefore, to *prevent* the customer from defrauding the company, by making it difficult or impossible to interfere with the proper registering of the meter.

In order to make it difficult for the customer to tamper with the company's electric service wires and meters, it is, of course, necessary to know how the offender is most liable to defraud the company. The following methods are common, and most of them can be guarded against without great expense or inconvenience on the part of the company.

The most common way of "beating the meter," as installed under ordinary conditions, is to use "straps," as already referred to and shown in Fig. 1. In some instances the offender has gone so far as to attach concealed wires ahead of the meter, through a concealed switch, and then connect these wires to his own circuits inside of the meter, thus furnishing around the meter a highly efficient shunt which can be opened or closed by means of the concealed switch, thereby causing the meter to stop or run very slowly when the switch is closed, and to run at normal speed when the switch is open.

Under the term "beating the meter," can also be included all methods of taking current from the company's wires before they reach the meter, as is frequently done in places where the meter is supplied with current through wires which are concealed. When the conditions are such that the tap is hidden, it is generally made permanent and supplies power to a part of the customer's system which has been disconnected from the other part of his service which is on the meter. Sometimes current for lighting is taken temporarily directly from the service switch by simply hooking wires on to the bare terminals. A practice of this kind can, however, readily be discovered by an examination of the terminals which would perhaps show burns and pitting from arcing and poor contact.

As it is customary for practically all light and power companies to charge a higher rate for light than for power, the customer is sometimes induced to connect up part of his lighting installations on the power wires, which, of course, gives him a rate lower than he is entitled to. It is often difficult to determine whether or not the customer intentionally connected incandescent or arc lamps to the power service meter, instead of to the lighting meter, and the company should be careful not to accuse wrongfully a customer on this account. It is best simply to order the lighting equipment disconnected from the power service.

The Edison direct-current, three-wire system with grounded neutral offers the greatest opportunity to persons inclined to divert current from the meter. On this system the following methods have been observed:

(*a*) By disconnecting the outer wire, to which the shunt connection for the meter is attached, current may be drawn from one side of the three-wire system inside of the meter without being registered.

(*b*) Should one of the outer wires be disconnected from the fuse terminal and connected to the other outer wire, both of these wires will operate in parallel, the neutral being the common return, consequently the magnetic fields due to the series coils in the meter will oppose each other when the load is balanced and the meter will stand still. However, if one side should have a greater load than the other, the meter will run forward, and if the other side should have the greater load the meter will run backward.

(*c*) In many instances, which have been noted, the shunt lead from the meter connected to the neutral wire had been broken after the tape had been removed, after which the tape had been replaced, thus making it difficult to readily observe that this connection had been tampered with.

(*d*) There have been reported cases where the neutral wire has been grounded inside of the building and then disconnected both inside and outside of the meter. The disconnection would prevent the excitation of the field, leaving the armature dead, thus preventing registration. The grounding of the wires inside of the building and disconnecting other wires at various places, as above referred to, is, however, not easily done by the customer, and cases of this kind are not common.

(*e*) Where the company furnishes auxiliary service to isolated plants the inspection should be frequent and rigid. It is not uncommon for isolated plants to use the company's current during the latter part of the afternoon on the peak of the load, and also during the entire night, permitting the shutting down of the plant during the night and also relieving it of the peak load. Next morning, when the isolated plant is started up, it can readily be thrown in parallel with the company's system, and, by increasing the voltage on the generators, current equivalent to that used from the company's mains for the peak and night load will be returned and the meter will run backwards to any extent desired. The company is the loser in a case of this kind, inasmuch as these plants may draw current from the company's mains during the peak of the load (when the power is expensive) and then return power in small quantities during the day, in which case the company actually maintains a storage plant for the auxiliary consumer without any compensation. Some means should be provided in cases of this kind to prevent the meter from running backwards.

The ordinary consumer who is bent upon defrauding the company usually tries to tamper with the meter, and in some way prevent it from registering. Some meters offer greater opportunities in this respect than others. Of the many ways in which proper registration can be prevented, only a few will be referred to, as follows:

(*a*) Where screws are used for holding name-plates, the removal of a screw may permit the insertion of a fine wire, which will prevent rotation of the meter armature or disk.

(*b*) A small hole drilled in the case of the meter will allow to be inserted a wire to interfere with the operation of the meter. There have been observed cases where the holes drilled have been so small that they could not be detected without a very careful examination, and some offenders have gone so far as to fill the hole with some substance which has made it absolutely impossible to find it, and after each inspection has been made, the wire has again been used for retarding the armature.

(*c*) Certain types of meters which have thin metal covers, and are so constructed that the mechanism of the meter is held to the base by screws inserted from the outside, offer opportunity to force the case against the mechanism, thus throwing it out of alignment, and the disk will then be retarded by the stationary permanent magnets mounted on the base of the meter.

(*d*) When the meter is held to the wall by screws which are accessible from the outside, it is possible to throw the meter out of plumb, thereby increasing the friction considerably and preventing the meter from operating on light loads.

(*e*) Should the entrance to the case containing the mechanism be made through bushings which are larger than the wire, foreign substances may be forced into the meter, and it is obvious that under such conditions the delicate mechanism will not operate properly.

(*f*) On certain types of meters it is possible to remove the glass in front of the dial, thus allowing the meter to be stopped, or the hands of the dial to be turned in any position desired; when the glass is properly replaced the discovery of the changes is difficult.

(*g*) Meter seals are often tampered with, and most seals can be opened without detection. Lead, which, in connection with either a flexible or a solid wire, usually constitutes the seal, can readily be cut or pried open after the meter has been sealed, and the wire

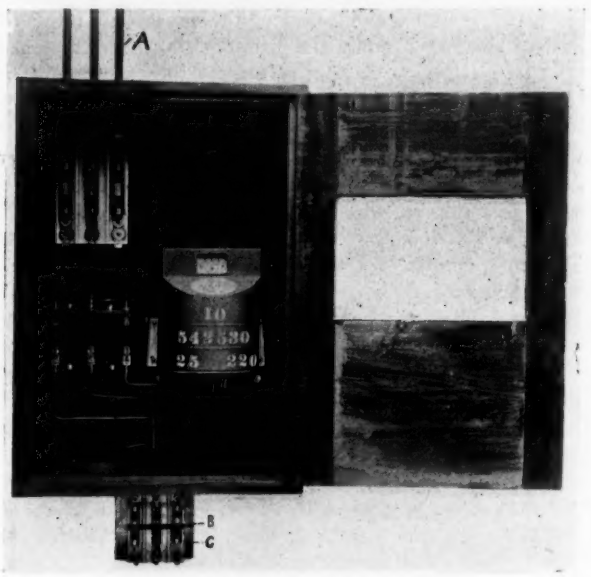


FIG. 4.—SERVICE BOX.

can be pulled out, thus opening the meter, and the offender can interfere with its operation in any way he pleases; and after the meter has been tampered with, most seals can be replaced without much liability of detection.

(*h*) A sharp blow with a hammer on the base of meters which have jewels will sometime injure the jewel, and the meter will then not register on light loads, and on heavy loads it will run slow, due to excessive friction.

The foregoing is a brief description of the more common methods employed by persons inclined to defraud the company. It would be difficult to devise a meter which would prevent a consumer from practicing at least some of these methods.

A large number of public-service corporations now insist upon locating all of their meters in the basement of the customer's premises, so that all meters, whether they be for gas or electric service, can be inspected and read with greater ease than if the electric meters were located on the upper floors, as has been, and still is, the custom in many places. The customer should be expected to provide a loop for each electric meter. If the service wires are underground, this usually involves no extra expense, but if the wires are overhead, the customer will have to provide an extra set of wires from the cellar to the attic where the service wires enter.

It is evident that in large buildings, where there are many floors and several offices or apartments on each floor, the task of running

FIG. 5.—HAND PUNCH.

a large number of loops to the cellar is quite considerable, but there is no better way to prevent tampering with the company's service than to have all meters located as far away from the customer's installation as possible.

It is practically impossible to prevent a customer from tampering with the meter or diverting current from the company's service, unless the service switch, cutout and meter are located in a suitable box, which the customer cannot open. The company's service wires should be lead covered, or they should be pulled through an iron pipe which enters the service box, thus preventing the customer from making any connection to the wires ahead of the meter.

Fig. 4 illustrates a service box which has been designed so as to meet all standard requirements. The service wires, which in this case are lead covered, enter the service box at *A*. The lead covering extends some distance inside of the box. The wires are connected to a suitable cutout, which is provided with fuses having a capacity of nearly double that required for the installation. Below the cutout is mounted a standard service switch. The wires from the meter come out through bushings in the bottom of the box where the house-switch is mounted, and to which the wires are connected. Below or at the side of this switch may be mounted the house cutout, provided with fuses of the proper capacity for the installation.

The customer's wires are connected to the house cutout. *B* indicates the house switch, and *C* the house cut-out. The service box is so designed that there are no screws or nails of any kind on the outside of the box. The sides are held together with small angle irons, which are secured to the wood from the inside. The illustration clearly shows that when the door is closed there is absolutely no opportunity to make contact on the service switch or cutout, and the meter cannot be tampered with. The service box is held to the wall by screws entering from the inside, therefore it is impossible to alter its position after the door has been closed. A suitable glass window is fitted in the door of the box so that the inspector can observe the condition of the service cutout, switch and meter and the meter can be read without opening the door.

The customer may connect or disconnect his wires from the company's lines by closing or opening the switch *B*, and in case of trouble the fuse in the cutout, *C*, will blow first, so that the trouble man can insert a new fuse without opening the box. In case of

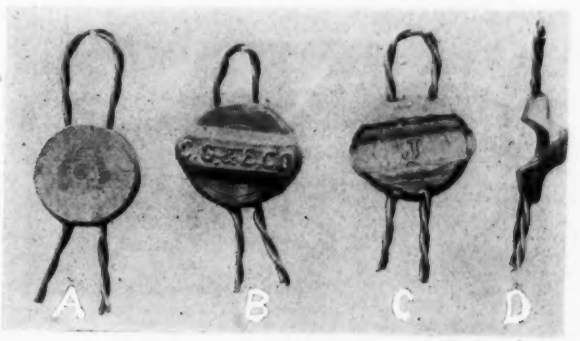


FIG. 6.—SEALS.

necessity the switch inside of the box may be opened by breaking the glass window in the door, which is large enough to give free access to the switch. The door of the box can be provided with metal fittings (for a lock) secured to the woodwork from the inside, and a Yale lock or a seal similar to a meter seal can be used for locking the door.

The more important advantages of a service box of this kind may be briefly summed up as follows: It is foolproof, dustproof, insectproof, always plumb, and it need not be opened except when it is necessary to change or readjust the meter. There is no objection to the installation of a service box of this kind, but the increased expense for the box and the cutout and switch, etc., will, of course, have to be considered. It is, however, not necessary to make general use of such a box, which may be required only for those installations which are most liable to be tampered with.

Fig. 5 illustrates a new form of hand punch, which has been designed for gas and electric meter seals, and which has met with great favor wherever it has been introduced. Fig. 6 shows the wire and the lead seal in different positions. *A* is the plain seal and the wire before it has been subjected to the punch. *B* shows the front of the seal after it has been through the hand punch, and the initials of the public service corporation are clearly shown. *C* illustrates the back of the seal with the letter *J* raised in the lead. This letter refers to the employee of the company who closed the seal. Each man should be held strictly responsible for his hand punch, and, in case the punch should be lost a new letter or figure must be used and the old one should be canceled. *D* is a side view of the seal and the wire after it has been closed. The impossibility of loosening or tampering with this seal will be readily appreciated.

Where a single public service corporation controls both the gas and the electric installations, the gas department may use hand

punches with "figures," and the electric department may use "letters" for the identification of the punches.

Having a clear understanding of the methods usually employed for defrauding the company, it should not be difficult to prevent theft of current. It is of prime importance that sufficient evidence be available, if it should become necessary to prosecute a customer for theft of current.

The Electric Lighting Situation in Paris.—I.

IN 1889 and 1890 different companies asked the city of Paris to grant franchises allowing them to construct cableways and the right to distribute electrical current. These franchises were granted subject to the following conditions:

1. That the outlying portions of the city be supplied with current as well as the center, and that the distributing system should cover an area bounded in each case by a certain portion of the fortifications and two irregular lines joining the extremities of this portion to the center of the city (hence the name sector, which was given to each district).

2. That the city reserve the right to purchase the entire installation at the end of ten years.

3. That all distributing systems be given over to the city at the expiration of the franchises.

Furthermore, the city, not wishing to trammel itself for a long period, as it had done with the gas company, limited the franchise to 18 years.

Thus it is that the several franchises will expire in the course of the next two or three years. The question is, What is to be done at this time?

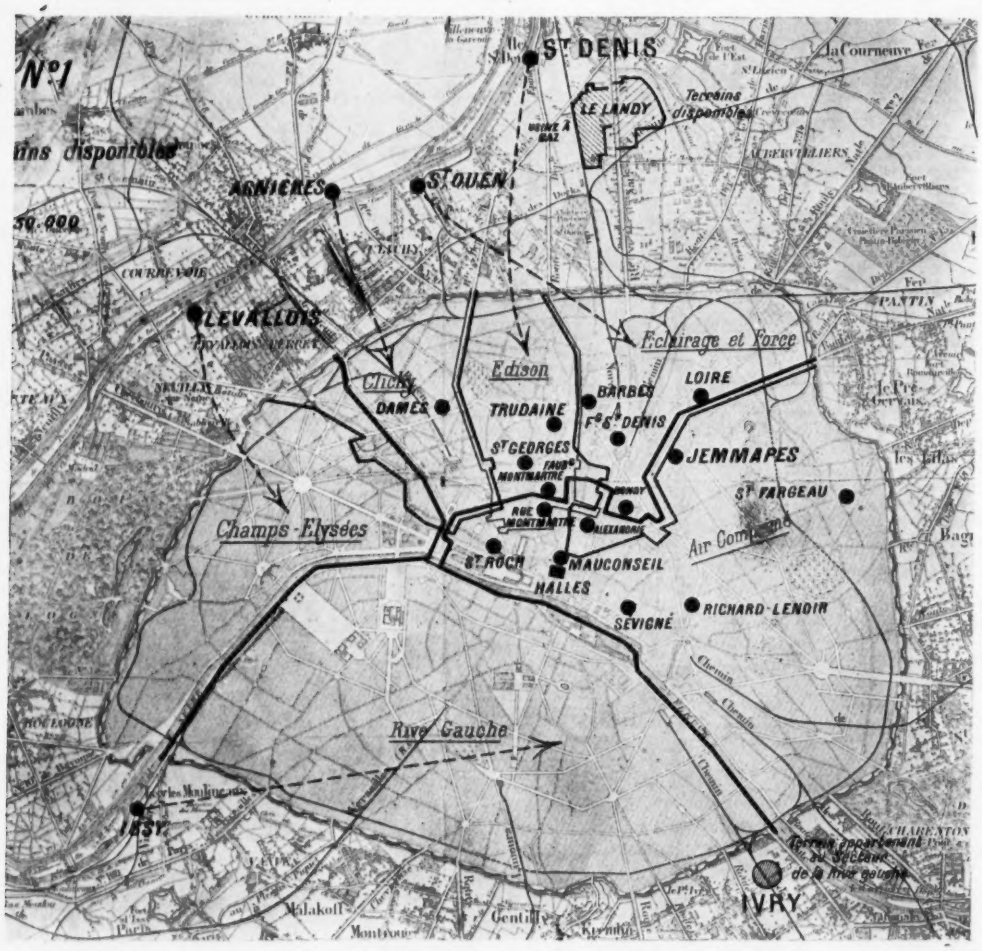
For some time past the municipal government has been considering this very important question. In order to obtain the opinion of competent electricians, an ordinance of the Préfect of the Seine dated August 6, 1904, instituted a consulting technical commission. At the request of this commission the chief engineer of the lighting service of Paris, M. Lauriol, opened the investigation with an impartial study of the advantages and disadvantages of the different probable solutions of the problem; he also discussed the opinions submitted by various private persons and companies at the request of the government.

Recently the technical commission completed its task. and February 11 it published its conclusions in a report drafted by the well-known engineer, M. Picon, reporter of the commission.

The papers upon which the discussions of the commission were founded, together with the official report form a collection of most interesting material for technical men, the most important features of which we shall now point out. Before, however, taking up the subject at hand it will be necessary to give the reader some idea of the present status with respect to the distribution of electrical energy in the city of Paris.

As will be seen from the accompanying map, Paris is very unequally divided among six companies, doing business in the same number of sectors. In these sectors some municipal installations have lately been added, the most important of which is the Halles sector. The first four of the sectors furnish direct current. Following the order of the district which they supply, these are, the Clichy sector, Edison sector, Light and Power sector and compressed air sector.

Although these sectors all furnish direct current, they do not use the same method of distribution. Thus, the Light and Power sector uses the two-wire system, the Edison the three-wire and the Clichy and the compressed air the three-wire. In each the pressure is 110 volts. The remaining two sectors—Champs Elysees and Rive Gauche, distribute single-phase current. The current is brought by concentric cables under a pressure of 3,000 volts to the consumers' transformers, where it is reduced to 110 volts; the sector Champs Elysées uses 40 cycles and the sector Rive Gauche 42 cycles.



MAP OF PARIS, SHOWING LIMITS OF ELECTRIC LIGHTING SECTORS.

The municipal sector of Halles has two systems of distribution, namely, direct current at 110 volts, and single-phase current at 2,400 volts, with transformers on the consumers' premises. It is thus seen that four systems of distribution are in use in Paris, three for direct and one for alternating current.

The same diversity exists as to methods of generation. The old direct-current sectors situated within the fortifications contain small machines (from 100 kw to 750 kw in the most modern stations) which generate 110, 220, 440 volts, according as the system of distribution is two, three or five-wire, and feed directly into the system. The location of these stations may be seen upon the map: Rue des Dames for the Clichy sector, Avenue Trudaine and Fauborg Montmartre for the Edison sector, Quai de la Loire Boulevard Barbé and Faubourg St. Denis for the Light and Power sector, and St. Fargeau and Boulevard Richard Lenoir for the compressed air sector.

However, at the present time, these stations are used as generating stations only in cases of emergency. They serve simply as sub-stations for the large power houses, which, except one, have been built outside the city. These power houses are as follows: The three-phase station, at Asnieres, which furnishes three-phase current at 5,000 volts and 25 cycles to the station in Rue des Dames of the Clichy sector, where it is transformed into direct current at 440 volts by means of rotary converters and motor-generators. The Saint Denis station, which furnishes high-pressure (2,200 volts) direct current to the Trudaine, Montmartre and Opera substations of the Edison sectors, where are located motors direct-connected to 220-volt generators. The Saint Ouen station, which furnishes two-phase current at 6,000 volts to the above mentioned stations of the Light and Power sectors, where rotary converters of the Maurice Leblanc system transform it

into direct current at 110 volts. Lastly, the Jemmapes station, situated within Paris on the bank of the Saint Martin Canal, which generates direct current at 440 volts, and feeds storage batteries in the Saint Roch, Mauconseil and Sevigne substations. As to the generating stations of the two alternating-current stations—Champs Elysees and Rue Sanche—they are situated, respectively, at Levallois Perret and Issy, outside of Paris on the banks of the Seine. The first contains five 1,200-kw generating units and one of 600 kw, and the second contains thirteen generating sets of from 450 to 1,000 kw.

The total power of all these stations, or rather, the total power used by the city of Paris—because some of the stations outside of Paris also furnish current to the suburbs—is about 43,000 kw. In 1903 they furnished 33,000,000 kw-hours to 35,600 consumers, and distributed through 619 kilometers (384 miles) of cableways.

The Mercury Arc.

At a meeting in Boston last week of the American Electrochemical Society, Dr. E. Weintraub presented a paper giving the results of an investigation on the properties and nature of the conductivity of the metallic vapors, carried out in the research laboratory of the General Electric Company. The investigation was started with the practical purpose of using the arc discharge in metallic vapors, and especially in mercury vapors, as a source of light. The starting of an arc in metallic vapors is first treated, It was pointed out that the distinctive feature of the conductivity of gases and metallic vapors, in contradistinction to that of metals and electrolytes, is that under ordinary conditions and in the absence of exterior ionizing agents the current itself has to create the material which is to carry it from one electrode to the other. As this material does not exist at the beginning, some special means must be used to start the discharge, and thus in gases and vapors is encountered the problem of starting which is absent in conduction through metals and electrolytes. To take the particular case, an exhausted glass tube having two mercury vapor electrodes is connected to a source of moderate electromotive force, no current passes, no matter whether the tube is cold or filled with mercury. Two different ways may be used to start the arc discharge. The first one consists in bringing the two electrodes into contact and then separating them. This method is exactly the same as the one used in the carbon arc, the flame arc, etc. The second one is founded on the use of a high-voltage shock. The Geissler discharge through the residual gas or mercury vapor in the tube creates a conductive path, the moderate direct-current voltage follows, and the arc discharge is initiated. Both methods were used by the investigators of the mercury arc, especially by Arons, in Germany, and Cooper Hewitt in this country.

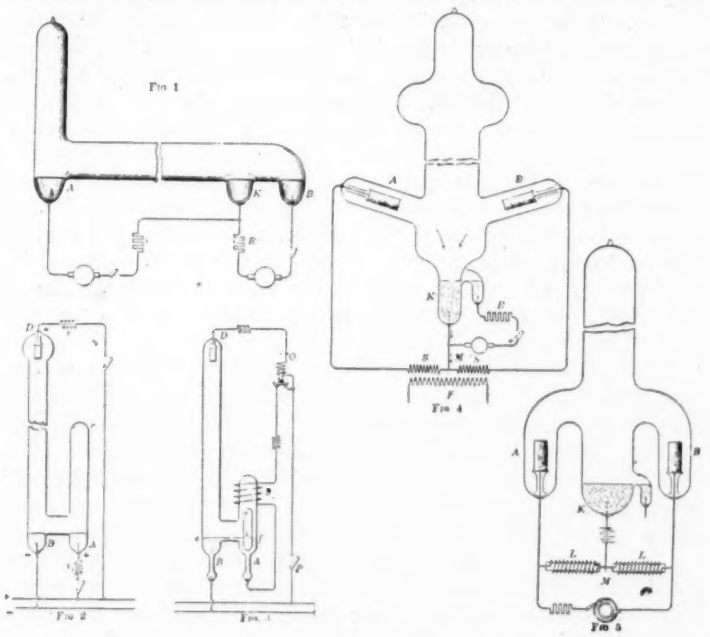
A new way of starting an arc discharge in mercury vapor was the outcome of theoretical conceptions on the mechanism of the arc and the function of the ionization at the cathode surface formed in the course of investigations made by the author. According to these conceptions, an arc discharge in metallic vapors is a discharge deriving its carriers at least in the immediate neighborhood of the cathode from the material of that cathode. The application of a moderate electromotive force is of itself insufficient to start the process by which these carriers are formed out of the material of the cathode. The new fact discovered was that this formation of carriers (the "ionization" process) is started and the arc discharge made possible if a spark or a small arc is produced at the surface of the cathode. The following experiment will serve to illustrate this statement:

The tube is represented in Fig. 1. *K* is a cup filled with mercury. *A* and *B* are electrodes of graphite, iron or mercury. In the figure they are shown as mercury cups. The tube is exhausted by a Sprengel pump to the highest possible vacuum, and by some means, such as heating from outside, or by the arc itself, the gases are driven off from the walls of the tube and the anode material. Two different sources of direct current are used, one applied to *K* and *B*, the other to *K* and *A*, in such a way that *K* is the negative pole of both. If, now, the little arc, *B K*, is started by bringing the electrodes into contact, and separating them, the other arc, *K A*, starts instantaneously. If the connections are changed in such a way that *K* is the common positive pole of the two sources, the arc, *B K*, does not cause the starting of the arc, *A K*. The fundamental importance of the cathode in the process of starting an arc is illustrated by this experiment in a simple and striking way. We can dispense in the tube of Fig. 1 with the use of two different sources and use the same source with different resistances in the two branches. In Fig. 2, *B* is the cathode, *D* and *A* are both connected to the positive pole; *r* is a large resistance; *r* is a small resistance used for the purpose of regulating the current in the main arc, *B D*. By slightly shaking the tube, the arc *B A* starts, whereupon the arc *B D* can then be opened and the auxiliary arc disconnected.

For the practical use of this starting method the operations of separating the electrodes *B* and *A* and discontinuing the auxiliary arc the moment the main arc is started must be performed automatically by the current itself. One of the arrangements that have been devised is represented in Fig. 3. *K L* is an iron plunger, *S* a solenoid and *O* a magnetic cut-out. The solenoid *S*, in pulling up the plunger *K L*, produces the auxiliary arc. The current in the main arc flows through the magnetic cut-out, and automatically opens the circuit of the auxiliary arc.

It is interesting to remark that the old method of starting an arc by contact is based also on excitation of the cathode; only, instead of having one arc instantaneously formed by another, we have a continuous growth, a short arc producing a longer one.

As a development of the old contact method, the following method was employed, based on the use of a carbon filament of high



FIGS. 1 TO 5.—MERCURY ARC LAMPS.

resistance, which first establishes connections between the anode and cathode, so that on closing the switch the current first flows through the filament. By means of a solenoid and its magnetic action on an iron plunger, the filament is lifted and the contact between its lower end and the mercury cathode broken. Exactly as in the case of the old form of contact method, the small arc lengthens until the carbon filament is short-circuited by the arc.

As a result of various investigations of the above character a series of different types of lamps has been developed, all being founded on the principle of the excitation of the cathode and differing merely in mechanical details.

The space separating the electrodes has an important influence on the velocity with which the starting takes place, but this influence is mainly of a negative character. The space must present as little hindrance as possible to the flow of ions starting from the cathode surface. Accordingly, the degree of vacuum must be the highest obtainable, and the more complete the exhaustion the more instantaneous is the starting. If foreign gases or inert ordinary mercury vapor are present, the starting is slow. The ionized vapor is seen to rise from the surface of the cathode, and slowly move along the tube, impeded in its use not only by the gases present in the tube, but also by the mercury vapor which volatizes from the heated surface of the mercury cathode. When the vapor reaches the anode the arc will eventually start, but if the pressure of the foreign gases is high enough the arc does not establish itself at all. Although it is relatively easy to produce the high vacuum necessary for the instantaneous starting, it is not easy to drive out completely the gases absorbed on the walls of the tube and in the anode material. The vacuum in the lamps is liable, in some cases, to get worse with

use, and some means had to be provided which would render the starting of the arc instantaneous, even with a somewhat impaired vacuum pressure of foreign gases (above .01 mm.). As inert mercury vapor also hinders the propagation of the ionized vapor, even perfectly exhausted lamps start harder when hot than when cold. The propagation of ions and the starting of the arc are facilitated if a carbon filament of high resistance is suspended from the anode in such a way that its lower end is separated but a few inches from the mercury surface. When the ionic stream reaches the lower end of the filament, there is established a small current which helps the starting of the main arc.

As to the function of the anode, it plays no rôle whatever in the starting process; merely receiving the carriers of the current without any previous excitation.

In the study of the conditions of the stability of the mercury arc one meets with a phenomenon observed in all arcs, i. e., the existence at each impressed voltage of a lower limit of current, below which the arc is not stable and goes out. The experiments performed on the mercury arc led to the conclusion that the physical cause lies in the conditions prevailing at the very surface of the cathode. Under ordinary circumstances there is on the surface of the mercury cathode a bright spot, which continually wanders about on that surface. This spot is, according to the conceptions of the author, the place where the production of ions takes place, and its continuous motion means a disturbance of the ionization process and a danger to the existence of the arc. The wandering can be avoided either by making the surface of the cathode small, of the same magnitude as that of the spot, or by having a wire of iron or platinum project above the surface of the mercury. In this latter case the cathode spot is centered on the mercury surface right around the metallic wire. In order to limit the surface of the cathode, without changing anything else in the tube, narrow tubes of refractory material, such as silica or porcelain, are fastened inside of the mercury cathode. The arc is started by means of a carbon filament which dips into the small tube. The filament is lifted by the passage of the current, the current broken and a little spark produced inside of the narrow tube. The rest of the mercury surface outside of the small tube is then inert and does not carry any current. This experiment shows strikingly that the arc has its beginning in the cathode spot.

Both methods lead to the same result, the lowering of the minimum current at which the arc subsists. With 120 volts applied and about 80 volts consumed by the arc, the low limit of current is normally at about 3 amp. When the cathode surface is made very small, this limit decreases to 1.5 amp., and with a platinum wire it becomes as low as 1 amp. These values can be made much smaller if reactance is placed in the circuit, or if the impressed voltage is higher.

The conductivity of the arc depends on the relative amounts of ionized and inert mercury vapor. If a sufficient condensing space is provided, so that the pressure of the ordinary mercury vapor volatilized from the cathode is kept down to a certain value, the conductivity of the arc is almost exactly proportional to the current. The voltage across the arc is, therefore, almost independent of the current. If, however, sufficient condensing space is not provided, the amount of inert mercury vapor increases continually, and with it the resistance of and voltage across the arc, until finally, when the voltage across the arc comes too near to the impressed voltage, the arc goes out. Foreign gases present in the tube have influence similar to, and even more pronounced than that of mercury vapor.

The conditions prevailing at the surface of the anode have no appreciable effect on the stability of the arc. If the anode is made of mercury, great amounts of mercury vaporize because of the heat generated at the anode. This increases the amount of mercury vapor in the arc, and thus indirectly changes the conditions of stability of the latter. This is obviously a secondary effect; otherwise, the anode has just as little effect on the stability of the arc as it has on the starting process.

As has been shown, the ionization process at the cathode must be initiated if an arc discharge in metallic vapors is to be established, and this ionization process must be kept up by the supply of a certain amount of energy if the arc is to maintain itself. It is in these facts that lies the explanation of the difficulty that previous investigators have found in maintaining an alternating-current arc between metallic vapors. With every change of polarity the ionization process at the cathode dies out and moderate electromotive forces are insufficient to start that process by themselves on the surface of the other electrode when the latter becomes of negative sign. It is, therefore, obvious that if an alternating electromotive force of moderate value is to maintain an arc in metallic vapors, one metallic electrode must permanently keep its negative sign, notwithstanding the perpetual change of polarity. This, if realized, would mean a unidirectional flow of current in the arc, and consequently rectification of the alternating current.

If, referring to Fig. 1, the electrodes, K and B, are connected to a source of direct current, K being the cathode, and a source of alternating electromotive force of a few hundred volts is applied to K and A, that half of the alternating current which has the direction $A\,K$ (K cathode) passes, since the ionization process at the surface, K, is kept up by the direct-current arc; the opposite half wave is completely suppressed. The arrangements by means of which both halves of the current wave are made to pass in the arc and are superposed in the same wire are mainly applications of electrical principles to the given case. Of the devices used by the author, two are mentioned. In both of them the tube contains three electrodes, one of mercury, the others of graphite, iron or mercury. The one electrode of mercury serves as the cathode, the two others, which we will suppose to be made of graphite, serve as anodes of the rectified arcs. In the first arrangement, represented in Fig. 4, a transformer is used, the ends of the secondary of which are connected to the two graphite anodes. A wire taken out from the middle of the secondary is connected to the cathode. One-half wave takes then in the arc the direction $A\,K$, the other the direction $B\,K$, and both are superposed in the same direction in the neutral wire of the transformer. The current derived is pulsating, and if the rectified voltage or current is low, usually a small direct-current arc, springing from the same cathode, is necessary to keep the cathode alive during the zero point of the current. If a constant-current transformer is used this direct-current arc can be dispensed with.

In the second method the alternating voltage is directly applied to the two graphite electrodes and two reactance coils are connected in the way shown in Fig. 5. As in the first arrangement, two arcs are playing in the tube, both having the same cathode. The reactances store up energy, while the current flowing in them increases and discharges through the arc in such a direction as to keep the cathode K alive. In this case, as in that of the starting method previously described, a great number of modifications and combinations have been devised, for both monophase and polyphase currents. By means of arrangements of this kind, voltages up to 15,000 have been rectified, giving unidirectional e.m.f. as high as 6,000 to 7,000 volts. This last arrangement may become of importance, even for laboratory use, when unidirectional high voltage is desired.

One phenomenon observed in the mercury arc rectifier is of theoretical importance. As is seen from the figure, the alternating voltage is applied directly to two electrodes, which, when the rectifier is working, are surrounded by a highly conducting vapor. Without the knowledge of the cathode properties and of the necessity of creating an ionization center on its surface, the fact that no short-circuit takes place would be incomprehensible. Under certain conditions, however, this short-circuit takes place, one of the two electrodes becoming the cathode of an arc discharge. This phenomenon was termed "arcing" of the rectifier. There is no doubt that under normal conditions a small leakage current flows between the two anodes of the rectifier. A number of experiments have shown that if an electromotive force is applied to two exploring electrodes placed in the mercury arc a slight leakage current of the magnitude of 1 milliampere flows between those electrodes. The question of arcing is, accordingly, identical with the following one: Given two electrodes, separated by a highly ionized vapor and an electromotive force applied to them, under what conditions will a cathodic center form and the small leakage current transform into an arc discharge? By a series of experiments, a number of factors influencing the arcing have been determined, so that rectification could be carried up to many thousand volts alternating current, with practically no arcing at all.

For the purpose of adding red lines to the spectrum of the mercury arc, the arc discharge in vapors of other more or less volatile metals was investigated. Alkali metals proved especially suitable. The experiments showed that the regularities found during the study of the discharge in mercury vapors hold good for all other metallic vapors. The cathode phenomena, the bright cathode spot, the behavior toward alternating voltage are exactly the same. Accordingly, all of the experimental facts established hold good for the discharge in metallic vapors in general.

To the question whether the ionization process at the cathode is accompanied by an actual transfer of matter or not, the mercury arc presents a better opportunity for study, since the arc takes place in a vacuum and the mercury undergoes no chemical change. Unfortunately, the phenomenon is complicated by the volatilization of mercury, due to the heat generated at the electrodes.

An attempt was made to get quantitative data by using mercury arcs with cathodes made of material less volatile than mercury. If a piece of graphite or any other conducting material that does not combine with mercury, and a mercury cup, both enclosed in an exhausted tube, are connected to, respectively, the negative and positive poles of a source of an electromotive force, the electrodes brought into electrical contact and separated, an arc is formed with the solid electrode as cathode. The behavior of these solid cathodes is the same as that of the mercury cathode. A bright spot wanders on the surface of the solid piece and wherever that spot strikes the cathode disintegration of its material takes place. This disintegration is characteristic of the cathode of a metallic arc in an exhausted space. If a piece of charcoal is used as a cathode, the motion of the cathode spot leaves fine lines and grooves burned, so to speak, into the material. The loss of weight of these solid cathodes is usually very small. The largest part of it is, however, due to the mechanical disintegration of the material which accompanies the electrical one, which circumstance deprives the results of theoretical significance. We can, therefore, conclude from these experiments that a transfer of matter either does not take place at all, or is so small as to be of the order of magnitude that would be required by the value of the electronic mass accepted in the modern theories.

The second question of special interest in connection with the theory of the arc refers to the cause of the ionization process at the cathode. The formation of current-bearing particles does not in all probability take place at all in the arc itself. The potential drop in the arc and that at the cathode surface (about 5 volts) are so small that production of ions by collision seems to be excluded. As the anode plays no appreciable rôle during the starting and the running of the arc, we are led to the conclusion that in an arc through metallic vapors in an exhausted space, the cathode is the only place where the current-bearing material is formed.

The assumption that the cathode is one of the places where ionization takes place has been made by many previous investigators. In view of the fact that solid bodies heated to a high temperature are known to render gases conductive (an effect observed by the author in the case of mercury vapor), the ionization process at the cathode was attributed by some of the investigators to the high temperature prevailing at the cathode. Experience with arcs in metallic vapors, and special experiments made to elucidate this point, do not support this view. The boiling point of mercury being low, it is necessary, of course, to limit the supposed area of high temperature to the cathode spot itself.

The facts that speak against this assumption are as follows: First, as mentioned above, the cathode spot moves rapidly along the surface of the cathode. If high temperature were a necessary condition of the ionization process, the cathode spot would not be expected to move constantly away from the exceedingly hot part to the cold part of the surface. Second, if the spot is fixed by means of a platinum wire no evidence of a high temperature in that spot can be found. The faint light emitted by the spot surrounding the wire reminds one, especially when the current is not very high, rather of a phosphorescent light than of light produced by high temperature. Third, efficient cooling of the cathode does not produce any change, either in the cathode spot or in the arc. To cool the cathode efficiently, the following method was used:

A platinum cap, sealed into glass, was connected to the negative pole and a surface of mercury to the positive. By heating the mercury, some of it was made to condense on the platinum cap, so that this thin layer of condensed mercury could be used as a cathode. The cap was cooled by rapidly flowing water. The arc showed no difference in its behavior, with the exception that the cathode spot wandered about with an extraordinary velocity along the mercury layer. In this case one can still claim that some infinitesimally small point of that layer has at any moment an exceedingly high temperature. One will, however, admit that this assumption is not a very probable one.

Fourth, if solid cathodes, such as graphite, iron, platinum, etc., are used, the spot on the cathode surface, to judge by its color, has not a very high temperature, so that the rapid disintegration is due not to volatilization by heat, but rather to purely electrical causes. If, by an auxiliary current, the solid cathode is heated up in such a way that one part of it, by reason of its higher resistance, is brought to a very high temperature, the cathode spot wanders about the surface of the cathode without showing any preference for the hot spot, as would be expected if high temperature were the cause of ionization.

Fifth, in the case of an "arcing" rectifier, where we have to deal with the formation of the cathode spot, temperature of the solid electrodes plays but an unimportant rôle. The electrodes may be very hot while surrounded by ionized vapor without causing arcing. This is very significant if compared with the relative ease with which at first sight seemingly unimportant factors produce arcing. If, for instance, the electrodes are of mercury, a drop of mercury hitting the surface, or any other mechanical disturbance, is liable to produce a cathode at the point where impact takes place. These and a number of other facts led to the conclusion that the temperature of the cathode is not the cause of ionization in the case of metallic arcs in an exhausted space. The temperature of the cathode is probably in some way connected with the boiling point of its material and is a result of the ionization process rather than the cause of it. The facts quoted above are not, of course, intended to disprove the influence of high temperature on ionization, which is too well proven in other cases. In arcs in metallic vapors considered here, the temperature of the cathode seems not to be the ionizing agent.

The time has not yet come to give a complete theory of the arc. In working for years with the mercury arc the author had, however, to make for his own use some working hypothesis. This hypothesis seems to agree with all the facts observed and was helpful in the course of investigations, and in some points agrees with the views of previous investigators, while in some others it differs.

Starting from the hypothesis developed by a number of modern scientists, according to which the conduction in metals is due mostly to the negative electrons, and from the postulate that the mechanism of conduction in different states of matter must have the same general characteristics, it is assumed that the mechanism of the conduction in the arc is similar to that in metals and that an arc is, electrically considered, in the main a flow of negative electrons directed from the cathode toward the anode. While in the metal the number of electrons is a given quantity and the conductivity accordingly constant, the number of electrons crossing the surface of the cathode and entering into the arc must be proportional to the current. Accordingly, the conductivity of the arc is proportional to the current. The process of starting an arc serves to initiate the process by which the electrons are driven out from the metal into the space. The starting is probably produced by purely electrical causes. If this process, by means of which the negative electrons are projected out of the metallic mass is started, it goes on of itself so long as a sufficient amount of energy is applied. The disintegration of the cathode is a mechanical accompaniment of this electrical process. The light emitted by the arc is not due directly to the radiation of the electrons. These negative electrons are probably the same in all arcs, and the light emitted changes according to the molecular material through which these electrons move.

Oil in Boilers.

In a paper on "Boiler Furnaces and the Effect of Oil on Their Ultimate Strength," recently read by Mr. D. B. Morison, before the North-East Coast Institution of Engineers and Shipbuilders, of England, the author said that if the surface of a furnace in a boiler for, say, 200 pounds pressure, were clean, the temperature of the metal would never reach the point at which its original tensile strength would be appreciably reduced, even under very high rates of evaporation. If, however, the surface were simply rubbed over with a very thin coating of mineral oil, the temperature would at once rise to over 650°, even with a moderate rate of evaporation. An appreciation of this fact would explain many a so-called mysterious collapse of apparently clean boilers. A disastrous accident of this nature came under his notice some time ago, in which the furnaces of a passenger steamer collapsed in mid-ocean. The boilers were apparently clean, with no appreciable scale on any part, and the principal cause of the accident was the use of a very inferior oil for swabbing the rods and lubricating the auxiliary engines. The oil becoming emulsified with the feed water, and being therefore unfilterable, passed into the boilers and was deposited on the metal.

Maintenance of Meters.

BY W. J. MOWBRAY.

To the company supplying electric energy which is measured by meters and charged for accordingly, the maintenance of meter accuracy is of supreme importance. Losses in other apparatus become insignificant when compared with the loss of revenue from meters that are allowed to follow their natural tendency to run slow. For example, in a steam boiler a drop of 10 per cent from normal efficiency would be detrimental to approximately the same percentage in the single item of the cost of coal, whereas in the metering system it would be 10 per cent of the entire gross revenue to which the supplying company is legitimately entitled. Furthermore, if a metering system did actually deteriorate so as to record 10 per cent less than the true energy, this loss would by no means remain constant; it would continue to increase.

Periodic overhauling is the obvious and generally adopted means of maintaining meter accuracy. Overhauling—a strict examination for correction and repairs—is efficient in proportion to the cheapness and accuracy with which it is done and to the permanence of the result. Means of making the result as permanent as possible will be considered later. Attention will first be called to a portable test-meter used by the writer for the accurate and almost instantaneous determination of the percentage by which a meter is running fast or slow.

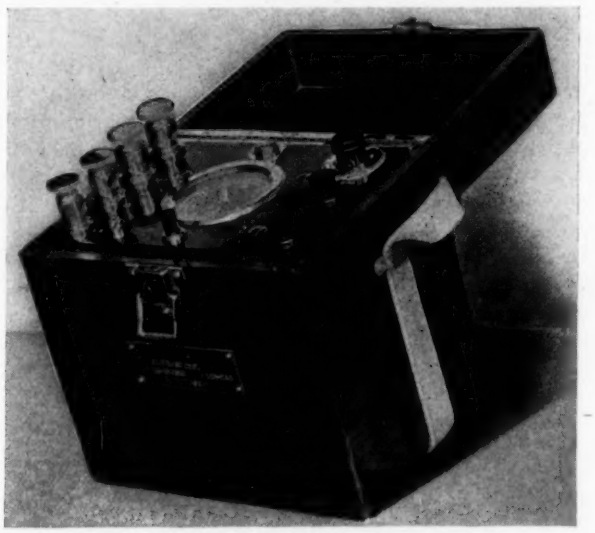
This meter is similar to a customer's ordinary watt-hour motor-meter in that it has a rotating armature, each revolution of which represents the passage through the meter of a certain number of watt-hours. A rotating armature in a test-meter is advantageous in that its revolutions and those of the meter under test are directly comparable, making it immediately apparent whether the latter runs faster or slower than it should. Another advantage is that the comparison of revolutions is quite unaffected by fluctuations in pressure or current which would tend to render an indicating instrument unreadable because of the swinging of the needle.

The ampere capacity of this test-meter can be varied at will by means of a plurality of windings. To understand the utility of an adjustable carrying capacity, it should be noted that a meter generally operates most accurately at full load, and that as the load is decreased the meter is likely to become inaccurate. This is because it is impossible entirely to eliminate friction from the bearings and contacts of a meter armature, or to keep this unavoidable friction at a constant value. Suppose this friction to vary sufficiently to cause an inaccuracy of one per cent at full load and full torque, then at one-half load and one-half torque the proportion of this same friction variation to the torque would be doubled, and the inaccuracy would also be doubled. Similarly at one-quarter load the inaccuracy would be increased four times and at one-tenth load ten times. Suppose it be required to test a meter of 15-ampere capacity. On full load a corresponding 15-ampere winding of a test-meter could be used with a high degree of accuracy. On a light load, however, say 1.5 amperes, both meters would be subject to the serious light-load inaccuracy above noted. In the latter case an adjustable ampere capacity in a test-meter can be utilized by changing, say, from a 15-ampere to a 1.5 ampere winding, thus restoring the test-meter to full-load conditions of torque and accuracy. Meters of widely varying capacity have to be tested in practice, and a test-meter should accordingly be equipped with at least three different current windings and two different pressure windings.

A test-meter in use by the writer can be started or stopped at will by means of a switch, the meter under test meanwhile rotating continuously; in practice this test-meter is allowed to rotate only during the interval that the meter under test takes to make 1 or 10 revolutions. A comparison of the watt-hours corresponding to the latter revolutions with the true watt-hours as recorded by the test-meter shows instantly whether the rate is fast, slow or correct. Explanatory of the relation between armature revolutions and watt-hours, it may be noted that integrating watt-hour meters have what is called an armature or disk constant. Generally speaking, this armature constant in any particular meter is the number of watt-hours corresponding to one armature revolution. Hence, the number of revolutions multiplied by the constant gives the watt-hours. If either of these factors—revolutions or constant—be made equal to 1, 10 or 100, the multiplication necessary to obtain the watt-hours resolves itself into a mere shifting of the decimal point. Accordingly, in the case of the meter under test, 1 or 10 revolutions are taken, and therefore the constant of that meter with proper location of the decimal point, becomes equal to the recorded watt-hours. The true watt-hours can be similarly obtained from the revolutions of the test-meter, since in the latter the *constants* are arranged decimally; and it can at once be seen whether the consumer's meter records more or less than the true energy.

Accurate and cheap calibration is, however, of comparatively little value if a meter soon returns to its former condition of inaccuracy, therefore, in old meters, appliances should be provided for increasing the permanence of calibration. Owing to the advance of the art, modern meters are fairly reliable, but their improvements are not generally applicable to the older forms. Suitable appliances have, however, been developed, chiefly by the large operating companies, with the result that meters manufactured some ten years ago can now be made at least equal in efficiency of operation to the most modern ones. Among the most prominent of these appliances are the adjustable friction compensating coil, the cupped or concaved diamond bearing, and a means for correcting the disposition of the drag-magnets relative to the field coils.

The friction compensating coil in operation carries a current of constant value, and can be moved into such proximity to the rotating armature that its accelerating effect exactly neutralizes the retardation due to friction. Commutator friction increases very rapidly when a meter is first put in service, but after a time it assumes practically a permanent maximum value. If at this time the compensating device be adjusted, a great part of the inaccuracy due to commutator friction will be permanently removed.



TEST-METER.

The cupped diamond bearing is partly the result of what has been termed by Lockwood the "cross fertilization of the sciences." Diamond being the hardest known substance, was long recognized as the most desirable bearing material, but it seemed impossible to get any one to grind out a nicely curved and highly polished cavity in a diamond to receive the lower end of the vertical steel shaft. In the search for a new optical effect, however, the lapidary art has so developed that no serious difficulty is now experienced in satisfactorily cupping the surfaces of a diamond. As a meter-bearing, it seems to embody the ultimate degree of perfection, the initial friction being a minimum and the wearing qualities a maximum. It is especially necessary in the old types of commutator meters with their very heavy rotating elements, because in these meters the material next in hardness to the diamond and which is generally used, sapphire, quickly breaks down in service.

The object of changing the disposition of drag-magnets is to prevent meters from running fast after being subjected to the tremendous currents resulting from short circuits. In old meters the stray flux thus produced found a convenient path along the drag or braking-magnets; this tended to demagnetize them, thus causing the meter to record more than the true energy. It was found that by changing the disposition of the magnets so that the stray flux traveled *across* instead of *along* them, this effect was minimized, and manufacturers changed their designs accordingly. Old meters

*A paper presented at the 196th meeting of the American Institute of Electrical Engineers, New York, April 28, 1905.

can now be modernized in this respect by removing the magnets and attaching additional small bases thereto, the drilling of these new bases permitting the magnets to be remounted in the meter at right angles to their former positions.

In conclusion, it may be stated that this general system of overhauling has been productive of excellent results, and is coming into extended use as the importance of maintaining meter accuracy becomes more fully realized.

Proceedings of the International Railway Congress.

The International Railway Congress, which has been in session at Washington during the past two weeks, is very largely attended by important officials of steam railroad systems in all parts of the world. The work done is of an interesting character, but is not generally accessible owing to the fact that outside one or two general sessions the congress sits in sections, with closed doors, and that the business is transacted in two languages—French and English—a process that does not make particularly for speed. The work in one or two sections relates quite specifically to electricity, but that in Section 8 includes all the papers that touch on electric traction, and one or two of these papers may be noted here.

One of these papers is that of Mr. W. D. Young, the electrical engineer of the Baltimore & Ohio Railroad Company, who canvassed a number of steam railroads as to electric traction, and received data from eight of them. His conclusions are as follows:

First, that the larger roads that have interested themselves in the use and development of electric traction have increased in number from three to eight.

Secondly, the miles of track operated has correspondingly increased from 81.2 miles to about 172 miles.

Thirdly, there are special cases noted where the speed has increased from a maximum on the level of 40 m.p.h. to 48 m.p.h.

Fourthly, the load has not increased materially in the special case given, namely, the belt line of the Baltimore & Ohio, although there is a tendency toward increasing the train load, and to meet this condition the railroad company has purchased larger and heavier locomotives since the report of 1900 was made.

The writer states that his report had to go forward at a time when there are very important developments in the application of electricity to steam roads about to transpire in America, and about which at the time little could be written. These developments refer particularly to the electrification of the New York Central terminal and suburban lines in and about New York as well as those of the Pennsylvania Railroad. The remainder of the report is devoted entirely to a description of the single-phase alternating-current motor as developed by the General Electric Company on the Ballston extension of the Schenectady Railway Company.

Another paper is that of Mr. Ernest Gerard, inspector-general of the Belgian Ministry of Railroads, Posts and Telegraphs, and dealing with general progress in electric traction under two heads—track electrification and the use of electric automobiles for light, intermittent traffic. Taking up the question of electrification of steam railroads in Great Britain, the author at the outset gives considerable space to a paper presented by Prof. Carus Wilson at the Engineering Congress held at Glasgow in 1901, in which were discussed in great detail the comparative costs of working railroads by steam and by electricity. From that paper the present author quotes the following as the comparative cost under assumed typical conditions of operating as follows: Total operating expense per train-mile for steam, 11.85d. (23.70 cents); for electricity, 4.89d. (9.78 cents). The conclusion is reached that where there is sufficient traffic for a number of short trains, electric traction is relatively profitable. This truth is now generally agreed to. But the agreement was not arrived at without trouble and much experimenting. The author then proceeds to describe the various installations of electric traction on English railways. The fact is noted that on these systems the use of a fourth rail is also quite common, used either with or without the track rails for carrying the return current.

In finishing his report the author makes the following conclusions: In England, on the lines where electric working is now in operation, the electrification is attended with an increase in the number of trains and, consequently, in the facilities offered to passengers. The results obtained show that this is followed by an immediate increase in the number of passengers and in the receipts, with a material decrease in the cost per train-mile, with an increase in speed, a considerable increase in comfort, particularly in tunnels, and that this forms an attraction which has a serious influence on the number of passengers carried. The danger to people who have to move about in the neighborhood of the third rail, and the dangers which result from short-circuits, can easily be avoided.

As to electric automobile cars, in so far as it is a question of trains at rare intervals, on sections where there is no advantage in increasing the number of trains, automobile cars make it possible to realize some economy as compared with trains hauled by steam locomotives; electric automobile cars have the advantage that the speed can easily and readily be controlled with great simplicity and certainty from either end of the car without any necessity for turning the car around. Experience will show whether accumulators or dynamos driven by petrol motors give the better results.

A third interesting paper is that by Mr. Victor Tremontani, chief superintendent and manager of the electrical department of the Italian-Mediterranean Railway. This went into a great many details of comparison as to relative advantages and disadvantages. It was noted, for instance, that on the Milan-Varese road a speed of 77 miles per hour had been attained with electricity on a track that could not stand more than 49.7 with steam-hauled trains. Another point was that the average distance run by a steam locomotive is only 56 miles per day, whereas electric cars can run 298 miles per day. A steam locomotive requires 45 minutes attention before it starts and after the run, whereas electric locomotives require only a few minutes for this purpose.

Concerning data on the consumption of coal on the Milan-Varese-Porto Ceresio line after the introduction of electric traction, the author is able to state that experience shows that on an electric railway operated under similar conditions (as regards gradients and working), the energy consumed by a train having a useful weight of 197 English tons running on the flat at a speed of 56 m.p.h. amounts to 49 watt-hours per English ton-mile—that is, 9.66 kw.-hours per train-mile. Now, in order to obtain this on the electric train, it is necessary to burn at the central generating station, on the average, $2 \times 6 = 12$ kg. of best quality coal per train-kilometer (42.58 pounds per train-mile), losses in the mains, transformers and motors being allowed for. In the case of steam traction, such a train, having a useful weight of 197 English tons, must necessarily have a total weight of 276 English tons, and various statistics consulted enable the writer to state that the steam locomotive of this train, running at a speed of 56 m.p.h. on the level, would burn 63.86 pounds per mile. Thus, in the case of electric traction, there is a great saving not only in the consumption of energy, owing to the better utilization of the weight, but also in the amount of coal required for driving the train.

In this connection, the observations made on the lines of Milan-Varese-Porto Ceresio, Lecco-Colico-Sondrio, Berthoud-Thun, etc., lead to the conclusion that the cost of maintenance of rolling stock is less than on similar steam lines, and as this maintenance costs less, it may be added that it is simpler, more quickly carried out and consequently less extensive repairing shops will be required.

The observations made enable the author to affirm that the cost of lubrication is less with electric traction than with steam traction, and that the absence of smoke results in an important reduction in the cost of cleaning. Finally, the staff required on the train can be reduced in the case of electric traction to two employes—one for driving and the other for the train, as it is possible to replace the driver and the fireman by one wattman, or motorman, who does not need to go through a long and complicated apprenticeship (as required in the case of steam traction), and who consequently can be paid at a much lower rate.

Experience has proved the truth of what was theoretically expected in this connection, namely, that electric traction is cheaper than steam traction as regards track expenses. In fact, if there be taken into account in the case of electric traction, the maintenance and renewal of the appliances at the transformer sub-stations and of the third rail or other conductor, there are per contra no expenditure for construction and maintaining installations for supplying water to the boilers, and what is more important, the maintenance of the track is reduced. There is no doubt that with electric traction the track is subjected to less wear and tear than with steam traction, because there is no jumping, pitching or sideway oscillation, and hence the weight can be more evenly distributed over the wheels;

also because the tangential force on the rails is smaller and more regular with electric locomotives and cars; all these advantages evidently result in a material reduction in the cost of maintenance of the track.

In the section on suburban traffic an interesting discussion occurred as to the effects of the adoption of electricity. Mr. Alex. Wilson, assistant general manager North Eastern Railway, England, stated that the North Eastern has been operating for the past year a suburban service in the Newcastle district with electric power with the object of regaining the traffic from the competing tramways and to increase its amount. Not all the traffic has been regained from the tramways, but the amount handled has been considerably increased. The reduction in expenses has resulted in a net revenue which more than covers the interest on the extra cost of installation necessitated by the introduction of the electric power. The current is furnished at a reasonable price by power stations which do not belong to the railroad.

Mr. A. Mange, secretary to the management of the Paris-Orleans Railroad, stated that the Paris-Orleans Road operates electrically 12.4 miles (20 km.) on the Paris-Juvisy line, 100 trains daily instead of 75 as before the use of electric power. Four tracks are used, two for express tracks and two for locals. Trains are operated with reversible motors in front and behind. There are two types of trains: heavy trains, 286 tons (260 tonnes) and 1,000 seats; light trains, 73 tons (66 tonnes) and 650 seats. The labor of one man was saved, the motormen alone fulfilling the duties of the fireman and engineer of the steam road.

Mr. Brisse, assistant chief of operation of the Compagnie de l'Est (France), explained why the majority of the French railroad companies are still in a waiting state as to the electrification of their lines. He showed how the mixture of express and local trains on the same line does not necessarily reduce the capacity of this line, compared with lines where local trains only are operated.

Lightning Protection for High-Voltage Circuits.

At the monthly meeting of the New York Electrical Society, held April 26, Mr. N. J. Neall lectured on "Lightning Protection for High-Voltage Circuits." Mr. Neall's lecture had for its object a presentation of the possible ways in which this problem might be solved for potentials above 50,000 volts. Lightning was considered from the engineering standpoint in its two-fold effect: induced charges and direct strokes. Power transmission has brought the need of suppressing a short-circuit arc at the time of discharge over these gaps between line and ground; in order to accomplish this nearly every known scientific means of extinguishing an arc has been carried into a patent. Among these Mr. Neall enumerated the following: magnetic blow-out, moving part, air blast, non-arcing metal multigap, metal and resistance, confined arc, water column, coherer fixed, loose; fuse plain, arc in oil, in sand; horn, vacuum tube, wedge effect, e. g., the discharge path afforded by a pencil mark on marble; induction in shunt to circuit or counter e.m.f.

Besides lightning arresters, the choke coil came early into use, although its function was not at first fully appreciated. This type of protection has developed as follows: First, used as integral part of lightning arrester, Wurts pyramidal form, multispark coil, compensated coil, static interrupters, single coil, Elihu Thomson's skin-effect arrester, Gola arrester.

After a discussion of these features it was shown that little has been accomplished in the way of protecting against direct stroke, although overhead grounded wires have been proposed and metal towers are expected to do some good. Wood poles have been badly shattered, but owing to short wire suspensions the service has not been seriously impaired.

A method of this kind whose value has been highly commended is the equivalent spark-gap method, which was first used by Wurts, and later developed by Thomas. From this was reduced the law of protection: "Complete lightning protection must consist of a choke coil and lightning arrester; the former to have a high equivalent spark-gap, the latter a low one."

The principal need at the present time is clearly for a quantitative as well as for a qualitative development. The possible ways in which this problem may be solved rest on the fact that the disturbing conditions are electromagnetic and electrostatic.

In choke coil protection we already have a final form—a spiral of simple construction, its insulation and strength depending on given conditions. The lightning arrester, on account of possible reduction of short-circuits, grounds, etc., to a minimum, will be reduced to taking care of induced lightning discharges.

The winning type must be simple in form and construction, and may be based on the principle of the horn arrester; a fixed coherer of which the M. P. lightning arrester is the latest form, and permits a free static discharge, but no current to follow; or on the multigap (non-arcing) type, with a good resistance in series; possibly on all in conjunction, using the horn arrester as a lightning rod. Referring to skin effect, it was stated that the freedom of disturbance from static discharges said to exist in California, may arise from this skin effect of the wires themselves in holding back discharges of the capacity of the line.

For direct strokes, metal towers and lightning rods may be employed. For high-voltage, direct current, say 70,000 volts, as was experimentally tried in Switzerland a short time ago, there would be no difference in the lightning protection required, excepting that the multigap type will be superseded and the successful type of arrester would be based on the horn and coherer principles.

In conclusion, Mr. Neall said that, in general, the problem may be said to be far from solution, the natural development of transmission work having exceeded that in lightning arresting. The workers in the field are few in number and their efforts are not united. Much has been done by the large manufacturing companies, but much can also be done by practical men as well as by the scientists; the large number of technically trained men now in the field should exercise an appreciable influence on this investigation. The equivalent spark-gap method offers a means limited only by cost for meeting fully the commercial development involved in this problem.

In the discussion on the paper, Mr. Herbert Wirt said that reports recently received seem to show conclusively that a ground wire is not effective, and that many forms of arresters in service do not protect the apparatus. He cited a case where a ground in a stream of water had proved ineffective, for the reason that the plate simply touched on the rocky bottom. As to the horn arrester, it has only a single gap, while comparative tests have shown that a higher resistance is required to break an arc with a single than with a multiple gap. Examinations of a large number of standard low-voltage transformers, 2,000 volts primary, have shown that these rarely burn out between primary and secondary, but that the outside layers of the primary from line to line burn out, and the remedy for this is to place a spark-gap across the connection board of transformer, which will short-circuit when high potential exists between line and line, causing the fuses to blow. One hundred and fifty of these transformers are now being tested in actual service conditions.

Mr. H. L. Carpenter said experience has proven that the most prominent source of complaint resulting from high-tension charges on telephone lines is the breaking down of apparatus due to induced lightning discharges. It is not an infrequent occurrence in outlying districts, where aerial lines predominate, for a single lightning discharge, which perhaps does not strike any telephone lines, to produce inductive charges on several hundred telephone circuits. If it were not for the individual lightning arrester protection on these lines, great damage to apparatus would result. With the protection the discharges all pass to ground, with perhaps the only bad result of a few grounded lines caused by loosened carbon dust bridged across the small air-gaps of the lightning arresters.

The occasional crossing of telephone lines with power circuits, either of high-tension transmission, or low-tension railroad circuits, again brings in the lightning arrester. The standard lightning arrester for telephone work is well termed a "sneak current and lightning arrester." It is designed in the form of two small carbon blocks, with parallel surfaces separated by a thin sheet of mica but a few thousandths of an inch thick. A portion of this mica is cut away to allow a thin air-gap to separate the two carbon surfaces. One of the surfaces is grounded, and the other connected to one side of the line. A low-temperature, fusible metal plug is frequently cast in the ground carbon. A charge of about 300 volts or over jumps across the small air-gap, and is, therefore, carried to ground. If the charge results from a cross with a power circuit having plenty of current behind it, the fusible metal plug melts, introducing a direct low-resistance ground to carry off the power current. On many lines which might be susceptible to power crosses these pro-

tectors are supplemented with a long, low-capacity enclosed fuse, which blows as soon as the grounded current reaches any material value.

A somewhat new phase to the question of telephone line protection is being introduced by the development of the loaded aerial toll line circuits. These circuits are of a highly inductive nature, the individual loaded sections being practically isolated inductively from other sections when considering high-frequency lightning discharges. Where these loaded lines leave aerial circuits to enter underground cables, special choke coils are being considered to prevent lightning discharges from entering the underground circuits. The loaded lines are being protected by combination metal ground and short-circuit, jump-gap arresters. Lightning discharges which strike or are induced in the isolated sections of these loaded lines, it is hoped, will jump to ground, or cross the loading coils without serious result.

Mr. Ralph D. Mershon said that if the manufacturers will supply reliable transformers and lightning arresters, successful line insulators will be forthcoming for any voltage which may become commercially desirable. There is every evidence that, for the higher voltages at least, lightning protection will be much simpler than at present. The trouble with most of the high-voltage arresters is that of too high an inductance in the arresters themselves. It does very little good to make use of choke coils and other elaborate devices for "piling up potential," if, after the potential is "piled" the lightning arrester cannot take care of it, and most of the present lightning arresters are faulty principally because of the fact that their inductance is too high to allow the lightning discharge to pass readily. It is impossible to wind up a coil that is absolutely non-inductive, and the residual inductance will be very effective with a discharge whose frequency, or rate of change, is high. Mr. Mershon said that for this reason he does not look at all with favor on arresters having coiled resistances in series with them. In most of the high-voltage arresters on the market the path which the discharge must take through the arrester itself, irrespective of resistance, wound or otherwise, is very tortuous, and such a path must impede, to a very considerable extent, the discharge through the arrester.

Mr. J. L. Streever said he concluded several years ago that a direct stroke of lightning which would leave an iron smokestack and choose a path to ground by way of a guy wire attached to a pine guy stub or one that would splinter a new chestnut pole into kindling wood and completely ignore a set of approved arresters installed on the same pole and grounded to a water main, was beyond the control of any apparatus on the market. He also observed that on circuits strung through sections where there were a great many trees, and where numerous tree grounds were practically unavoidable in wet weather, and where it might be assumed that any static charge on the lines would be promptly dissipated, the damage to transformers was as great, if not greater, than on circuits that were known to be free from contact with anything but the glass insulators. It also appeared that the current induced in the lines by a lightning discharge in the vicinity, had a decided inclination to cross over from one wire to the other, and found an easier path through the transformer than by traversing the two sets of air-gaps in the arresters. In most cases the ensuing short-circuit destroyed the evidence desired as to the exact course taken by the discharge through the transformer, which could not have been by following the windings on account of the choking effect, but rather by crossing between the points of least resistance. In some instances where the case was quite full of oil the transformer showed little damage, except that the gases generated smashed the cover. The facts noted led to the conclusion that one feature of the problem might be solved by providing an easy and safe path by means of which the difference in stress on parallel wires might be equalized. Acting on this assumption, during the summer of 1904 he installed a number of six-gap arresters directly across the lines with a primary cut-out and a five-ampere fuse in series. Every arrester so installed gave evidence of having performed the work intended, and in only one instance was a fuse blown. The results were so satisfactory that the scheme will be tried on a larger scale this season. In conclusion, Mr. Streever suggested that an all-porcelain-covered arrester should be designed; an iron jacket for such apparatus is unnecessary and detrimental.

Mr. Francis W. Jones said that at present the menace from electric light and power wires, by reason of their high voltages and their liability to become crossed with telegraph wires in almost every town and village in the country, is much more serious to the telegraph company than lightning is, or has ever been. During the lightning season in the far West, overland Pacific lines are occasionally interrupted by lightning cutting the hard-drawn copper wires between the poles, as if cut by pliers, excepting that the ends of the wires are melted to points, and the wires, sometimes for two or three inches, on both sides of the cut, have very fine globules of copper adhering longitudinally in a row on the underside. Lightning rods have been erected upon every fifth pole. Referring to the importance of a good ground wire, Mr. Jones said that some years ago it was suspected that the ground wire of the Western Union Telegraph Company in Cheyenne, Wyo., was defective. It consisted of a wire running from the apparatus in the Western Union office to a large plate of zinc buried in a small river or creek near the town of Cheyenne. It was found that the water in this creek, on account of the solid rock bottom which existed up and down the stream for many miles, was highly insulated, presenting a considerable resistance between the telegraph wires and earth. This was ascertained by sinking a plummet upon a wire in an artesian well, which afforded a good earth connection.

The Postal Telegraph Company recognizes the importance of a good earth in the following rules in its book of rules governing the "Wiring of Offices":

"The importance of a good ground wire is very great. It should connect to earth as direct as possible and be without kinks or sharp bends, which prevent the free discharge of lightning. A good permanent ground must be secured by connecting the wire to a water or gas pipe (preferably water pipe). If a gas pipe is used, the connection in all cases must be made between the wire and the street service pipe, but if this is not practicable when an inside connection is made, care must be taken to make a metallic connection around the meter between the building pipe and the street pipe, so that the meter will interpose no harmful resistance, and the removal of the meter will not disconnect the ground wire.

"Where the water and gas pipes of cities, towns or villages cannot be used, proper ground connection can only be had in moist earth or in a river that does not flow a long distance in a channel of rock. A sheet of zinc, or tinned copper, of about one-sixteenth of an inch thick and 4 feet square should be buried horizontally in a hole deep enough to get below dry sand, rock or earth. The bottom of the hole, which must be where the earth is always moist, should have a layer of crushed coke two feet deep on which the plate is to rest, and over the plate a layer of crushed coke two feet thick, and the hole filled up with moist earth. Connection with the plate should be made by a hard-drawn copper line wire, the end being well soldered across the surface of the ground plate for the full distance of four feet if possible.

"In places where lightning is severe and causes trouble in quad and duplex relays, a table lightning arrester should be inserted between their main and artificial circuits, the mica plate in such arrester to be about two mils in thickness or sufficient to prevent the main line currents from seeking the ground through the arrester.

"Fuses are not intended primarily for protection from lightning, but are to protect our offices and apparatus from electric light and other foreign currents.

"In certain localities where terrific thunder storms are liable to occur and from which buildings may receive strokes of lightning that no known arrester can render harmless, experience has shown that telegraph offices have suffered much less, in proportion to their number, by damage from lightning bolts than other classes of buildings.

"It is very important that the proper thickness of mica plates be maintained in arresters and that no fuses except those of the required capacity be inserted in fuse blocks.

"Arresters are to be carefully examined after severe lightning storms, and kept clean and dry."

Tests of 5,000-Kw Alternators.

In the May issue of the *Electric Club Journal* Mr. L. L. Gaillard gives an account in detail of tests of the large Westinghouse alternators installed in the Seventy-fourth Street power house of the Interborough Rapid Transit Company, New York City. Each machine is a 5,000-kw, 11,000-volt, 25-cycle, 75-r.p.m., three-phase alternator, direct-connected to an Allis compound engine. The efficiencies determined are given in the following table, from which it will be seen that in each case the guaranteed efficiencies were exceeded:

	¼ load.	½ load.	¾ load.	Full load.	1¼ load.
Iron loss .....kw	38.69	38.69	38.69	38.69	38.69
Armature I^2R loss .....kw	1.51	6.04	13.59	24.16	37.75
Field I^2R loss .....kw	35.54	35.54	35.54	35.54	35.54
Total losses .....kw	75.74	80.27	87.82	98.39	111.98
Output .....kw	1250.	2500.	3750.	5000.	6250.
Input .....kw	1325.74	2580.27	3837.82	5098.39	6361.98
Efficiency ..... per cent.	94.29	96.50	97.71	98.06	98.24
Actual guaranteed ....per cent.	90.00	94.50	95.50	96.50	97.00

The guarantee provided that when a load of 263 amp. per terminal at 11,000 volts and at 100 per cent. power factor was thrown off, the e.m.f. would not rise above 6 per cent. with constant speed and constant excitation. From the data of the characteristic curves taken from the machine, it was calculated that the regulation would be within 4.5 per cent. The temperature rise above the surrounding air after a run of 17 hours with an average load of 5,000 kw was as follows: Field winding, 22.5° C.; armature winding, 22.6° C.; armature laminations, 25.5° C.

The insulation requirements were that after the machine had been assembled the insulation of the field winding from the frame should be subjected to a puncture test of 2,500 volts alternating for one minute and the armature subjected to 25,000 volts for thirty minutes. The tests were made by means of a 40,000-volt transformer, the periodicity being 25 cycles. A point of interest in this was when the test potential was first raised to 25,000 volts and for some minutes thereafter, a considerable static discharge was noticed taking place over the surface of the windings. As the test was prolonged, this static gradually decreased in intensity until after the lapse of about twenty minutes it almost entirely disappeared.

The Polyphase Patent Situation.

Last week we referred to a list of patents issued by the owners of the recently expired Tesla fundamental rotary field patents. A notice accompanying the list stated that certain manufacturers are offering to supply polyphase induction and synchronous motors and apparatus for use therewith because certain of the Tesla patents have expired, and intending purchasers of polyphase apparatus are notified that numerous other patents relating to these subjects are still in force. Below is given an analysis of the various patents named in the list, together with a brief account of the litigation in which some of the patents have figured. In addition to the patents in the list above referred to are several others which in a minor way have also figured in this same litigation.

TESLA PATENTS.

Of the Tesla patents the most important are the two fundamental patents on the split-phase system. These are Nos. 511,559 and 511,560, issued December 26, 1893, on applications filed December 8, 1888. Both of these patents have been in litigation for some years.

Judge Thompson, of the Southern District of Ohio, filed an opinion February 6, 1901, sustaining the patents in a suit brought against the Dayton Fan & Motor Company. The courts held that the first-mentioned patent covered the case of an alternating current passing through one energizing circuit and inducing a second current in the other energizing circuit; and also the case of two motor energizing circuits connected in derivation or multiple arc with the main circuit from the source. The second patent was held to cover apparatus for carrying out the method by derivation. It was also held that the retardation of phase by artificial means and its conversion from an element of disadvantage to one of usefulness in the transmission of electric power, must be regarded as evidence of invention. The court also pronounced against the defense that the inventions of the two patents in suit are covered by a prior patent issued to the same inventor, No. 416,193, issued December 3, 1889, on an application filed May 30, 1889. The claims of this patent are for an alternating-current motor having two or more energizing circuits, the coils of one circuit being composed of conductors of large size or low resistance and those of the other of fewer turns of wire of smaller size or higher resistance; also the combination with long and short field cores of energizing coils, including in independent circuits, the coils on the longer cores containing an excess of copper or conductor over that in the others; also, a field magnet composed of magnetic plates having an open center, and pole pieces or cores of different length, coils surrounding the cores and included in independent circuits, the coils on the longer cores containing an excess of copper, the longer cores being set in recesses in the iron core formed by the plates. It was held that in this latter patent there is claimed only a specific form of construction and not the method or process by which all motors of its class are operated. This decision was sustained on appeal in an opinion filed November 5, 1902. Judge Severen, who wrote the opinion, defined patent No. 511,559 as relating to a method or methods of transmitting alternating currents proceeding from one original source to both of the energizing circuits of a motor, and at the same time retarding the phases of the current in one circuit to a greater or less extent than in the other. The second patent was defined as relating to means employed in the transmission of electrical power to a motor through divided currents derived from a single current proceeding from the generator; the said divided currents being so regulated with reference to each other as to arrive at their destination in the motor-alternator.

In an opinion filed August 22, 1901, in a case in which the Catskill Illuminating & Power Company was defendant, and in which the Sheeffer meter figured as the alleged infringing device, Judge Lacombe held that two claims of the first patent were infringed and the first claim of the second patent. The second claim of the latter patent was stated to be restricted to apparatus in which the energizing currents are connected in derivation of multiple arc with the supply circuit, and this claim was declared not to be infringed. The Catskill suit was appealed and in an opinion written by Judge Townsend and filed February 25, 1903, the court below was reversed. It was held that the two patents were invalid on the ground that the system covered by the patents in suit was fully described in an article by Prof. Ferraris printed in an Italian journal April 22, 1888, which date was prior to the invention by Tesla.

The same two patents figured in litigation in the Massachusetts Circuit Court. On March 11, 1903, Judge Colt dismissed a bill alleging infringement of the patents by the Stanley Instrument Company on the ground that it had been shown by Judge Townsend that the Tesla patents were anticipated by the Ferraris publication. Upon appeal, in an opinion written by Judge Putnam, filed September 9, 1904, Judge Colt's decision was reversed, it being held that the testimony of a witness, Mr. Page, had established that Tesla had conceived the invention prior to the date of the Ferraris publication. Owing to the conflict in the two decisions on appeal, the case came before the United States Supreme Court on petition for a writ of certiorari. This was denied on the grounds that the two courts had before them substantially different records and therefore there was no conflict. The two patents were sustained in the United States Circuit Court for the Eastern District of Pennsylvania in a suit involving the Guttmann wattmeter. The opinion was rendered by Judge Archbald, who dismissed the defenses based upon patents issued to Dumesnil and Cabanellas and on the Ferraris publication, declaring the two patents to be valid. In another case before the United States Circuit Court for the Western District of New York, decided February 9, 1904, involving also the Guttmann meter, Judge Hazel held the two above patents to be valid, the defense being the Ferraris publication.

In still another case involving the Sheefer meter, Judge Kohlsaat, in an opinion filed March 26, 1904, sustained the patents, basing his decision upon previous decisions in their favor. Judge Buffington, in the United States Circuit Court for the Western District of Pennsylvania, on March 28, also sustained the patents in a case involving the Sheefer meter, basing his decision upon prior decisions sustaining the patents.

No. 416,194.—*Electric motor, December* 3, 1889. *Application filed May* 20, 1889. An induction motor with field and armature of equal strength when energized by a given current; the combination with field and armature coils of equal mass, of energizing coils containing equal amounts of copper. The specification states that such a motor will give the maximum output for the material used.

No. 445,207.—*Electromagnetic motor, January* 27, 1891. *Application filed May* 20, 1889. The motor is of the split-phase induction type, and is a self-starting, single-phase machine. There are on the motor two energizing circuits, one of which is connected directly to the source of supply of current, while the second circuit is placed in inductive relation to the first, the two circuits being constructed with different time constants. In the operation of this motor the current impulses in the first, or primary, coils produce currents in the secondary coils, and by the conjoint action of the two an unsymmetrical revolving field is obtained. There are three claims. In the Scott and Janney case it was held that this patent did not conflict with the patents there in suit, as it carried a distinct invention.

No. 459,772.—*Electromagnetic motor, September* 22, 1891. *Application filed April* 6, 1889. The seven claims relate to the combina-

tion of an induction motor used as a starting device for a synchronous motor. The induction motor is mounted on the same shaft with the synchronous motor, the number of poles of each being so chosen as to give to the former motor a speed greater than that of the latter. The use of a self-starting, split-phase induction motor is disclosed in the drawings, but not referred to specifically in the claims.

No. 487,796.—*System of electrical transmission of power, December* 13, 1892. *Application filed May* 15, 1888. The four claims cover a multipolar generator with independent armature circuits used in combination with a motor having independent energizing circuits, the type of neither the generator nor the motor being specified. The drawings show two-phase generators and motors, all of which are of the synchronous type. The claims dwell upon the use of a number of motor poles greater or less than the number of generator armature circuits.

No. 511,915.—*Electrical transmission of power, January* 2, 1894. *Application filed May* 15, 1888. *No.* 555,190.—*Alternating motor, February* 25, 1896. *Application filed May* 15, 1888. These two patents figured as a single issue in a suit against the Scott & Janney Co., decided September 27, 1899, in the United States Circuit Court of the Eastern District of Pennsylvania. Judge McPherson, in his opinion, held that the invention of the patents was for a specific method of obtaining difference of phase, namely, by induction instead of self-induction, and therefore they did not conflict with the fundamental rotary field and the fundamental split-phase patents. The motor has two independent energizing circuits through only one of which current from the source is passed. In the second circuit the current is produced by the inductive effect of the current in the first circuit.

STANLEY PATENTS.

No. 469,809.—*System of Electrical Distribution, March* 1, 1892. This is known as the Stanley transformer patent, issued on an application by William Stanley, Jr., filed August 15, 1888, and has been subject to litigation. On April 26, 1901, Judge Coxe handed down a decision in two suits of the Westinghouse Co. against the Saranac Lake Electric Light Company, alleging infringement of two patents on transformers, one issued to Rankin Kennedy, the other being the present patent. An abstract of the decision in this case was given in our columns in the issue of May 4, 1901. Judge Coxe held the Kennedy patent to be void, and upheld the Stanley patent on the ground that in this patent Stanley first described how to make a regulating transformer. He discovered that he could remedy existing faults by regulating the length of the wire on the primary coil of the transformer and laid down the following rule: "He determines the correct length of the primary coil by winding on wire after the transformer, in circuit, is connected with the dynamo until the loss of voltage represented by the formula C^2R equals the predetermined loss of energy to be suffered in the system." The patent came up on appeal from this decision, and Judge Lacombe, on January 14, 1902, wrote an opinion sustaining the lower court. Judge Lacombe stated the Stanley rule as follows: "It says you may determine the proper length of the primary coil by connecting the transformer in circuit with the dynamo with which it is to be used, and then wind on the wire until the loss indicated by the formula C^2R within the secondary can equal a certain loss of degree." He also held that this rule is part of the invention disclosed and claimed in the patent. The same patent is now in course of litigation, the defendants being the Montgomery Electric Light & Power Company. On June 18, 1904, Judge Coxe handed down an opinion in this suit again sustaining the patent, holding, first, that Stanley made a valuable invention; second, that the invention is described in the patent with sufficient clearness to enable skilled electricians to practice it without difficulty; and third, that the defendant had appropriated the invention, though its transformers were not designed in the manner pointed out by Stanley. An abstract of this opinion appeared in our issue of July 23, 1904. An injunction was granted but, as noted in our columns last week, the order for the injunction has been reversed on appeal on the grounds that in view of the large importance of the controversy the rights of the party should be reserved for decision until the final hearing of the case, which will come up in due course. In this case the alleged infringing device was a Wagner transformer.

No. 508,188.—*Alternate-current electric motor, Nov.* 7, 1893. *Application filed Oct.* 23, 1888. The motor is of the single-phase commutator type, and is similar to a repulsion motor in that the stator field winding constitutes the primary circuit. The secondary (rotor) circuit, however, is not closed upon itself directly, but is connected to a supplemental coil, which surrounds the armature, and through which there flows current, produced by induction from the primary

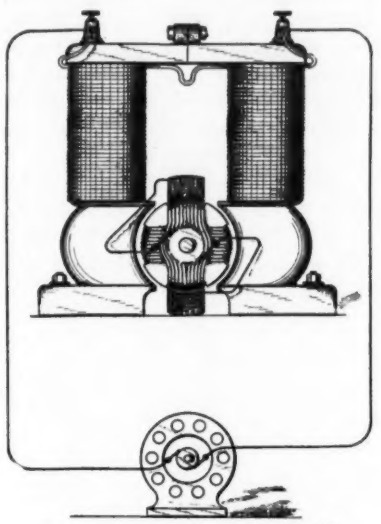


FIG. 1.—STANLEY, NO. 508,188.

circuit, in a direction to assist the polarizing effect of the current in the armature coils. There are four claims covering the combination shown in the accompanying illustration.

LAMME PATENTS.

No. 519,862.—*Method of and means for starting synchronous motors, May* 15, 1904. *Application filed April* 5, 1893. The invention contemplates the applying to the armature of the motor a starting current of low potential and large volume, thereby causing the armature to excite the field magnets by induction, and then gradually increasing the potential of the starting current to that of the supply circuit. The 9 claims, in addition to the general method of operation, cover the means for obtaining the variable potential. This patent is now in litigation, with the Indianapolis, Shelbyville & Southeastern Traction Company as defendant.

No. 582,132.—*Alternating-current motor, May* 4, 1897. *Application filed October* 30, 1895. The motor is of the induction type, having a revolving primary and stationary secondary. The invention relates to the construction of the stationary member. A starting resistance of proper value is included in the secondary circuit, and means provided in order to short-circuit the resistance when the motor reaches normal speed. The 15 claims cover the construction of the stator of the Westinghouse Type B motor.

No. 599,940.—*Non-synchronous electric motor, March* 1, 1898. *Application filed April* 30, 1894. The invention deals with the shape and size of the primary coils of an induction motor. Each coil of the distributed primary winding embraces an arc which is either greater or less than that resulting from dividing the entire circumference by the product of the number of poles and the number of phases. The object is to produce a sinusoidal distribution of field magnetism. There are four claims.

No. 609,990.—*Means for controlling non-synchronous alternating-current motors, August* 30, 1898. *Application filed March* 11, 1896. This patent relates to the use of a variable primary impressed e.m.f. for varying the speed of the motor. The four claims are for the combination with a primary member of a secondary member pro-

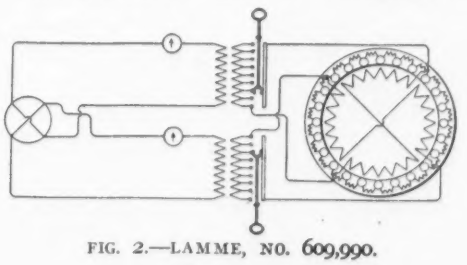


FIG. 2.—LAMME, NO. 609,990.

vided with a comparatively high-resistance winding directly short-circuited on itself, and means for varying the e.m.f. applied to the primary whereby the speed of the motor is varied; a small degree

of magnetic leakage between the primary and secondary; means for varying the speed of the motor consisting of a transformer for supplying current to the primary and means for varying the relation between the primary and secondary, thereby varying the e.m.f. supplied by the secondary; and means for varying the active lengths of the transformer secondary, whereby the e.m.f. applied to the primary of the motor is varied.

No. 609,991.—*Method of and means for securing constant torque in polyphase motors, August* 30, 1898. *Application filed February* 10, 1898. The motor is of the induction type, and has a comparatively high resistance in the secondary winding and a low degree of magnetic leakage, so that normally its torque increases continually with decrease of speed, and becomes maximum at standstill. In each of the supply circuits is placed a reactive coil, the core of which becomes saturated by a predetermined amount of current, the result being that the torque remains practically constant (at a reduced value) from standstill to that speed at which the current

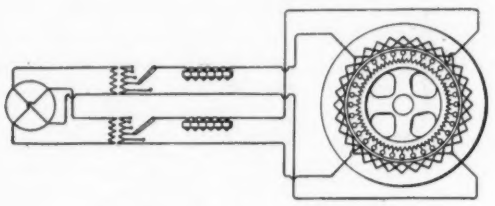


FIG. 3.—LAMME, NO. 609,991.

flows, causing the saturation of the cores of the choke coils. There are four claims, the first of which reads as follows: The combination with an induction alternating-current motor having a comparatively high resistance, secondary winding and a low degree of magnetic leakage, of a reactive coil in each of the supply circuits the core of which becomes saturated by a predetermined amount of current whereby a substantially constant torque is secured.

No. 610,067.—*Induction motor, August* 30, 1898. *Application filed July* 22, 1897. This patent relates to the construction of squirrel-cage secondary windings for the rotor of an induction motor, and the four claims refer to the use of ventilating blades on the resistance rings.

No. 633,856.—*Distributed winding for electrical machines, September* 26, 1899. *Application filed February* 6, 1899. The patent relates to mechanical details of the end connectors for the windings, which are covered by 8 claims. J. P. Mallet is a co-patentee. As usually constructed the portions of the armature conductors located in the slots of the core are in the form of bars, the ends of these bars being properly connected outside the core by means of end-connectors of suitable form, which are riveted and soldered or bolted to the ends of the bars.

No. 644,865.—*System of electrical distribution, March* 6, 1900. *Application filed June* 14, 1899. The invention refers to the method of obtaining e.m.f's lower than the normal voltages of a two-phase

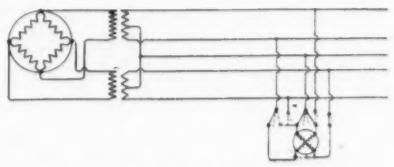


FIG. 4.—LAMME, NO. 644,865.

system by connecting the coils of the receiver between adjacent leads, or between adjacent single leads and a joint intermediate lead of the supply system. There are eight claims covering the various combinations of e.m.f's in quadrature obtainable from symmetrically and unsymmetrically disposed two-phase circuits. The cut shows the method by which can be obtained a voltage seven-tenths of normal value, at which e.m.f. the exciting volt-amperes for an induction motor, when lightly loaded, will be approximately one-half of the normal.

No. 759,183.—*Method of utilizing single-phase, alternating-current energy, May* 3, 1904. *Application filed December* 26, 1901. The invention refers to the use of the commutator type of single-phase motor, which was described fully in our issue of February 13 of last year. There are 8 claims relating to the proper proportioning of the field and armature windings.

HUTIN AND LEBLANC PATENTS.

No. 592,272.—*Alternating-current electrodynamic machine, November* 13, 1904. *Application filed August* 20, 1892. The invention relates to damping devices for preventing oscillations in the speed of synchronous motors and generators. There are six claims which cover the use of paths of low electrical resistance located within the path of the magnetic flux of the machine, at the margin of the interpolar space. This patent is now in litigation, the Bullock Electric Manufacturing Company being defendant.

No. 553,469.—*Alternating-current motor, January* 21, 1896. *Application filed November* 17, 1892. According to the patent, the secondary resistance of an induction motor is to be decreased in direct ratio with the frequency of the secondary circuit, so as to maintain the rotor torque at a constant maximum whatever may be the speed of rotation. Although the resistance is to be varied mechanically and the five claims cover means for producing the variation, the specification discloses no means other than the manual operation of a rheostat.

No. 12,223 (*reissue*).—*Alternating-current transformation, May* 24, 1904. *Original, No.* 754,371, *March* 8, 1904. There are two separate transformers in which the individual magnetic fluxes are in time quadrature. Two-phase e.m.f's may be obtained (or supplied) by winding similar coils on the cores of the two transformers, while three-phase e.m.f's may be supplied (or obtained) by passing around one of the magnetic cores for one of the three phases a number of turns proportionate to the sine of a certain arbitrarily chosen angle, and around the other core a number of turns proportionate to the cosine of the same angle; and for the other two phases using numbers proportionate to the sine and cosine of the same angle plus $2\pi/3$, or minus $2\pi/3$, respectively. The six claims cover the method in general without reference to specific apparatus.

DUSINBERRE PATENTS.

No. 763,379.—*Alternating-current induction motor, June* 28, 1904. *Application filed February* 27, 1904. The starting resistance of the revolving secondary is mounted in the form of a helix concentric with the shaft of the rotor, and variation in the effective length is accomplished by means of a contact device movable longitudinally upon the shaft. There are 12 claims covering the constructive details.

No. 763,547.—*Alternating-current induction motor, June* 28, 1904. *Application filed February* 27, 1904. The invention relates to means for automatically decreasing the resistance of the secondary circuit as the speed increases. The auxiliary resistance is assembled in spiral form and mounted so as to rotate with the motor shaft, which shaft also carries a contact device operated by centrifugal force whereby the amount of resistance included in the secondary circuit is decreased with increase of speed. The four claims cover the constructive features.

NOLAN PATENT.

No. 582,481.—*Fastening means for core plates of electrical machines, May* 11, 1897. *Application filed January* 20, 1897. In a circumferential groove in the core spider there is placed a spring metal ring which extends outside the groove and against a shoulder

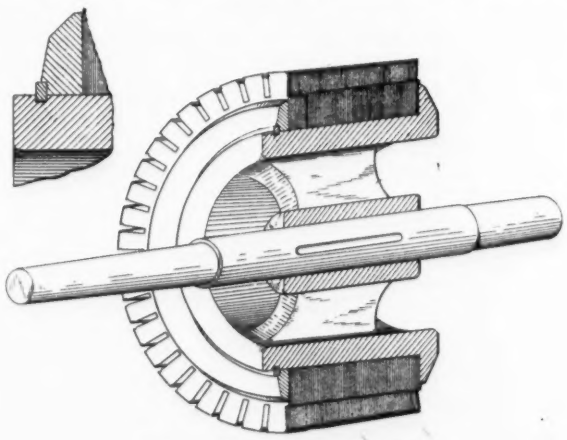


FIG. 5.—NOLAN, NO. 582,481.

on an annular plate between which and a flange on the core the laminæ are clamped. The construction is illustrated in Fig. 5 and is covered by four claims. This patent is now in litigation, the Bullock Electric Manufacturing Company being defendant.

The Meter Department of a Small Central Station.

At the recent meeting in Boston of the Association of Electric Lighting Engineers of New England, Mr. O. W. Halladay read a paper having the above title, which contained a number of points of special interest when considered in connection with the article which appeared in the issue of this paper for April 1, 1905, describing the meter-testing department of a large central station.

The author confined his remarks to the small station, which term was intended to apply to the one which, selling electricity by meter, has less than 1,000 meters on its lines. In the selection of meters it is necessary to exercise great care, because in studying the catalogues and circulars of various manufacturers, one finds that whatever make he is reading about, that particular meter is the best of its class, or perhaps in a class by itself far ahead of any other meter ever made. The meter selected should be one which will give the most accurate registration, and yet will not cost a prohibitive price, and one whose operating expenses are as small as possible, both in energy losses and in maintenance and care.

In considering the energy losses, that due to the current in the shunt coil is of most importance. Assume that this loss represents 8 watts. This value will be measured on the customer's meter only when enough additional power is used to cause the meter to register; that is, for about five hours a day. For nineteen hours a day this loss would amount to 56 kw-hours per year, which at 5 cents per kw-hour would mean a money value of $2.80. This showing forms a strong argument for a minimum charge on each meter.

The next point is the light-load inaccuracy. Many meters which will register within 2 per cent of correct on one-half to full load will be, perhaps, 10 to 20 per cent slow on one-fifth load and will not register at all on 30 watts or less. The light-load inaccuracy is a cause of considerable loss on night lamps burning an average of 6½ hours per night or 2,310 hours per year. Thus 30 watts for 6½ hours per day at 5 cents per kw-hour amounts to $3.50 per year.

Below are the results of some tests made during 1904 on requests either from the customer or from the office. The kinds of meters are designated as A, B, C.

	Tests.	Non-reg.	10 per cent. slow ⅕ to ¼	10 per cent. fast ⅕ to ¼	Within 3 per cent. on all loads from ⅕ to ¼
A.	173	(14) 8.1 per cent.	2.9 per cent.	0 per cent.	78.5 per cent.
B.	18	(2) 11.1 per cent.	5.6 per cent.	0 per cent.	27.7 per cent.
C.	46	(16) 35.0 per cent.	26.0 per cent.	2.2 per cent.	28.2 per cent.

The above is perhaps not quite fair as a comparison, since the "A" meters predominate. Below is given the result of tests of 19 "A" meters which had been in use at least two years in the houses of customers. All of these were 1,500-watt instruments. 36.8 per cent. were found to be within 2 per cent.; 79.0 per cent. were found to be within 3 per cent.; 10.5 per cent. were found to be over 5 per cent. fast or slow; 73.6 per cent. were found to be within 2 per cent. between ⅕ and ⅓ load; 94.6 per cent. were found to register on 15 to 20 watts.

One should decide on a meter which, after use for some time, say one to two years, shows good accuracy on all normal loads, will register on 15 watts or less, has small potential loss and is guaranteed by makers who will stand back of their guarantee.

Many small companies have no rule in regard to the location of a meter, but place it wherever the architect or wireman has chosen. Each company should have some well-defined policy in regard to the placing of meters, and some rules should be made governing the wiremen. The size of the meterboard and its general location should be stated, and in nearly every case a representative of the company should designate the exact location to the wireman. A meter ought not to be located in a laundry or other place which is liable to be very damp. It should not be placed on a coal bin or other partition liable to much jar, and ought always to be in basement, except perhaps in case of large office and apartment buildings. The meter should preferably be placed in a clean, dry, light part of the cellar and on a support free from jar and vibration.

The meter man is as important as the meter, and his selection requires some thought. The customer judges the company by its representative, and the meter man is the representative most frequently seen by the customer. The meter man should be thoroughly conversant with the policy of the company, and as far as meters go should give the customer all the helpful information possible. In case of testing a meter, especially on complaint, he should allow the customer to be present if he so desires, and should show him the results of the test, and in every way try to inspire confidence both in the company and in its meters.

The amount of work necessary on the meters depends very largely on the kind of meter used and the method used in testing. By far the most satisfactory test is made with an integrating wattmeter whose clock registers revolutions of the disc, and the periphery of which disc is divided into 100 parts. By using a system of constants giving the ratio of speeds of the various meters on the system, the percentage of error can virtually be read directly from the disc of the test meter. Besides the ease and rapidity of this method, it is well to note the errors eliminated, that of the stop watch being by no means the least important. The test meter is connected with its field coils in series with those of the meter to be tested, and its disc is brought to zero. Then its potential circuit is opened, and the test spot on the meter brought to a starting point. With main switch open, potential and load wires are now connected. Throwing in the main switch starts both meters. They are allowed to run until the disc of the meter under test has made, say, 10 revolutions, and then the main switch is opened. If the standard has also made 10 revolutions, the meter is correct, provided the disc constants of the two are the same. If it has made 9.98 revolutions the meter is approximately 0.2 per cent. fast. If the standard has a disc constant of 30, and meter under test has a disc constant of 36, then the ratio is 10 to 12, and the disc of the meter under test should be allowed to make 12 revolutions in order to read directly in percentage on the standard.

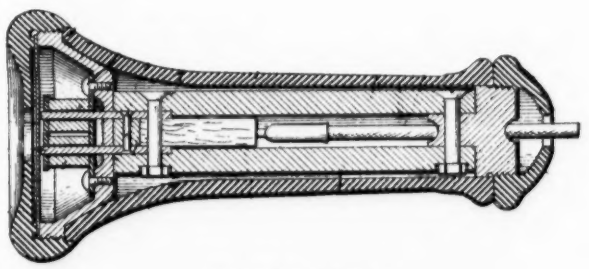
New Telephone Patents.

RINGER FOR COMMON BATTERY SYSTEM.

With most common battery systems a condenser is required in the bell circuit at each station. Many of the condensers heretofore used are bulky, and it is at times difficult to find a place about the set for them. C. E. Egan, of Durham, N. C., has patented a condenser and mounting which secures to the framework of the ringer and occupies a minimum space.

A NEW RECEIVER.

The cut below shows a receiver in which the magnetic parts are clamped into the shell by the tailcap. The pull of this cap as it is tightened home jams the ear piece against the shell and locks it. As the diaphragm is clamped by the ear piece, there is no chance



MASON RECEIVER.

for it to work loose. C. T. Mason, of Sumter, S. C., has patented this arrangement, and the Sumter Telephone Manufacturing Company has obtained the patent by assignment.

NEW TRANSMITTERS.

Patents are at hand for two transmitters. One of these, the invention of John Erickson, of Chicago, uses a disk-shaped electrode. This serves as a chamber for the granular carbon, and its edges contact with a felt packing to seal the chamber. The packing is in the form of a ring, and surrounds the other electrode of button shape. The patent is assigned to the Strowger Automatic Telephone Exchange.

The second transmitter is designed to permit of a maximum travel of the electrodes. To this end the carbon chamber is of resilient metal. The electrodes are attached at the center of the two heads, respectively, and thus are permitted to vibrate with the heads of the granule box. Mr. H. P. Claussen is the inventor of this transmitter, and has assigned his patent to the American Electric Telephone Company.

LETTER TO THE EDITORS.

Grouping of Cells to Obtain Maximum Current.

To the Editors of Electrical World and Engineer:

SIRS:—In the issue of the ELECTRICAL WORLD AND ENGINEER for October 3, 1903, there was presented by E. D. Pierce a proof of the law that a given number of cells produces maximum current through a given external resistance when they are so arranged that the internal and external resistances are equal. The proof by calculus was very lucid, but the algebraic proof was very cumbersome. In subsequent issues the law was further discussed by W. J. Humphreys and by Dr. K. E. Guthe, each of whom indicated additional proofs. A proof which seems to be simpler than any heretofore proposed is given below:

Let there be n cells in series and let there be m such groups in multiple. Then the current will be given by the expression,

$$I = \frac{ne}{nr/m + R},$$

where R is the external resistance, r the internal resistance of a single cell, and e its e.m.f. This value of the current is also

$$I = \frac{e}{r/m + R/n}.$$

Evidently I is a maximum when the denominator is a minimum. Observe that the product $r/m \times R/n$ is a constant. Then the real problem is to find the relation between two numbers whose product is constant when their sum is a minimum. Call these two numbers a and b, and let their product be k^2.

If their sum be designated by Z,

$$Z^2 = (a+b)^2 = a^2 + 2ab + b^2$$
$$4k^2 = 4ab$$
$$Z^2 - 4k^2 = a^2 - 2ab + b^2 = (a-b)^2$$

i. e., $$Z^2 = 4k^2 + (a-b)^2.$$

Z^2, and, therefore, also Z, is a minimum when $a = b$, i. e., when $r/m = R/n$, or when $R = nr/m$.

Evidently this is equivalent to saying that of all rectangles having the same area, the square has the smallest perimeter.

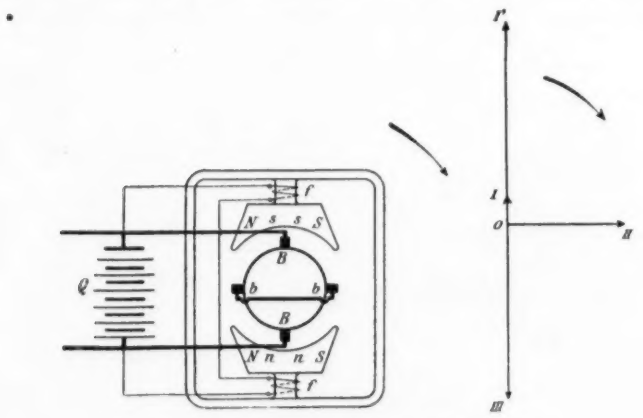
It is to be noticed that this demonstration assumes that the cells are all equal in e.m.f. and resistance, and that the branches put in parallel have the same e.m.f. and resistance.

ITHACA, N. Y. P. F. GAEHR.

DIGEST OF CURRENT ELECTRICAL LITERATURE

DYNAMOS, MOTORS AND TRANSFORMERS.

Dynamo for Train Lighting.—ROSENBERG.—A very long illustrated paper read before the Berlin Electrical Society on a system of train lighting worked out by the Allgemeine Elektricitäts Gesellschaft and in practical use on various German railroads. Each car is provided with a dynamo and a storage battery, as in various other systems. The essential new feature of the present system is the dynamo. Whether it runs in one or the other direction, it always gives a current of constant direction. It is diagrammatically shown in Fig. 1 as a bipolar machine. It has two sets of brushes, one, *B B*,



FIGS. 1 AND 2.—DYNAMO FOR TRAIN LIGHTING.

connected to a battery, the other, *b b*, short-circuited. If the machine runs in the direction indicated by the arrow, the primary field, *n n*, *s s*, is distorted as though a secondary field was superposed on the primary field. This secondary field, indicated by *N N*, *S S*, is due to the armature reaction and is made intentionally strong by the design of the machine. In the vector diagram, Fig. 2, the field, *n n*, *s s*, is represented by *O I*, the field, *N N*, *S S*, by *O II*. If the machine revolves in the opposite direction, the vector, *O II*, would be plotted to the left, instead of to the right. The brushes, *B B*, are influenced only by the field, *O II*, and since this field has opposite directions when the machine revolves either with or against the arrow in Fig. 1, it is seen that the brushes, *B B*, give a current of constant direction. If, now, these brushes are connected to an external resistance, the armature current taken from the brushes will produce a field indicated by *O III*, in Fig. 2. It is then necessary to provide ampere-turns *I I'* counterbalancing *O III*. For this purpose the primary exciting windings, which are connected to the storage battery, must be so dimensioned as to have all the time the ampere-turns, *O I'*. This is of great importance. At average speed the ampere-turns required for the production of the primary field, *O I*, are about 10 per cent. of those required for compensating *O III*. The current which flows through the short-circuited brushes is about 40 per cent. of the normal load current. Any increase of the load weakens the primary field and diminishes thereby the magnetizing current between the auxiliary brushes. When the speed increases to twice or several times the average value, the armature current can never increase by more than 10 per cent.; for when it reaches this value the armature ampere windings would be exactly equal to the primary ampere windings, and no primary field, *O I*, would be left. On the other hand, when the speed decreases below the average value, for instance to 70 per cent., the armature current tends to decrease. Even if it decreases only by 10 per cent., the primary ampere-turns leave an excess twice as great as before. Hence, the field, *O I*, is twice as great as before; and this, in spite of the lower speed, produces a 40 per cent. higher current between the auxiliary brushes, so that the increase of the secondary field is reversely proportional to the speed. The result is that the machine gives constant current for varying speed (beginning with a certain minimum speed). Or if the external circuit has a constant resistance, the voltage of the machine is independent of the speed. The absolute value of the current given by the machine can be adjusted accurately by the shunt regulator.—*Elek. Zeit.*, April 20.

Commutation.—CATTERSON-SMITH.—A paper read before the Birmingham Section of the British Institution of Electrical Engineers. The author describes experiments in which he recorded by means of the Duddell oscillograph the actual manner in which the current is reversed during commutation in one particular coil on the armature of a shunt-wound motor. The commutation curves show that in all probability the sine curve is rarely to be met with, and that the method of calculating the reactance voltage gives little more than a guiding figure; however, as a guide this figure is very useful, especially in the comparison of similar types of machines. Undoubtedly the best practice is to design a machine with its reactance voltage less than the brush drop whenever possible, especially with reversible motors having a fixed brush position. It is permissible to work with a higher value of reactance voltage on small than on large machines; on the other hand, it is generally possible without much trouble to keep the figure down on small machines, whereas large machines work more nearly at the maximum value allowable. Small machines with stiff fields are usually designed with a reactance voltage of about 2, although 4 volts will usually be satisfactory. With large machines it is difficult to keep the figure below 3 to 3.5 volts. With variable-speed motors, etc., which have to work with fixed brush position and weak fields, there is no reversing

field to help commutation, and the reactance voltage must be kept below 1 to 1.5 volts. These figures, of course, do not apply to machines with special commutation poles, in which the existence of a definite and fixed reversing field simplifies commutation immensely and allows of three or four times the values given above. In dealing with the problem of sparkless commutation we are chiefly interested in what is occurring while a segment is leaving the brush, and the part played by the self-induction of the coil. The effect of the self-induction of the short-circuited armature coil is first to prevent the current in the coil from dying away quickly, and then to retard the growth of the current from the other side of the armature, tending to a continuation of the current in the rapidly diminishing contact area of the brush and retreating segment. It is thus seen that the inductance of the coil causes the current density in the brush tip to rise to high values. The oscillograms show that the current is usually very late in reversing, and consequently the current density reaches very high values, rendering the brush tip very hot, sometimes incandescent, with resulting disintegration and sparking. The limit to the permissible density depends upon the shape of the curve: i. e., how long the high density lasts in comparison to the interval of short-circuit. The author states that the peak should not exceed about 300 amp. per sq. in., with ordinary carbon brushes.—Lond. *Elec.*, April 21.

Heating and Sparking Limits in Variable-Speed Motors.—BATE.—A paper read before the Birmingham Section of the British Institution of Electrical Engineers. In practice the reactance voltage gives a surer indication of the current and speed at which sparking will commence than any other criterion that has been advanced so far, but it is not an infallible guide in all cases. Tests of small bipolar motors give uniform results even with extreme variations in the speed and power of the machine, but for some reason the reactance voltage at which a multipolar motor will commence sparking is not so constant. Assuming that the reactance voltage may be taken as a safe guide for studying variable-speed motors, the author proceeds to notice its effect on the horse-power that can be obtained with different methods of speed control. He takes the case of a motor which, if wound for constant speed, would give 10 hp at 1,000 revolutions. He gives the following table showing the horse-power of such a motor as limited by heating and sparking.

METHOD OF CONTROL.	SPEED =	330	500	750	1,000	1,250	1,500
Variable field by rheostat or moving poles.	Heating	..	5	5	5	5	5
	Sparking	..	15	10	7.5	6	5
Variable pressure by reversible booster.	Heating	..	5	7.5	10	12.5	15
	Sparking	..	15	15	15	15	15
Variable pressure by multiple mains.	Heating	..	5	5	5	110 volts	
	Sparking	..	15	10	7.5		
Three-wire system.	Heating	..	..	220 volts	10	10	10
	Sparking				15	12	10
Double-wound armature Equal windings.	Heating	..	5	5	5	Series	
	Sparking	..	15	10	7.5		
	Heating	..	..	Parallel	10	10	10
	Sparking	..	..		15	12	10
Double-wound armature. Winding A, 2 turns per section.	Heating	3.3	3.3	Series			
	Sparking	8.2	5.5				
	Heating	..	4.1	4.1	4.1	A winding alone.	
	Sparking	..	8.2	5.5	4.1		
Winding B, 1 turn per section.	Heating		B winding alone		5.8	5.8	5.8
	Sparking				16.4	13.2	11

Attention is drawn to the last arrangement given in this table. The speed range is greater than is obtained by a double-wound armature with equal windings, and as there are three possible combinations instead of only two, the intervals in the speed that have to be filled in by field regulation are not so wide. The power available from heating considerations is certainly less than it would be if equal windings had been used, but this would not be a serious drawback for many purposes where the load is intermittent. There is one weakness, however—namely, that the commutation is poorest at a middle speed instead of at the highest speed. It certainly seems that this arrangement deserves more attention than has been given to it. When selecting the method of obtaining variable speed it is necessary to take the load factor into consideration. The importance of this point will become evident on comparing the duty imposed on the motor by a lathe, a ram pump and a planing machine, for instance.—Lond. *Elec.*, April 21, and Lond. *Elec. Rev.*, April 21.

Alternating-Current Commutator Motors.—SUMEC.—A paper read before the Vienna Electrical Society in which the author gives diagrams and formulas for predetermining the most important types of the alternating-current series motor, the repulsion motor, and the Latour-Eichberg motor. He gives comparative tables from which, contrary to Steinmetz, he concludes that at the best the repulsion motor has a power factor equal to the series motor, but it may have a smaller one. By carrying the comparison of both types somewhat further, he concludes that both types are about equivalent in value. The article is concluded by some remarks on starting, speed regulation and reversing the direction of speed.—*Zeit. f. Elek.* (Vienna), April 23.

Rotary Converter.—WOODFIELD.—An illustrated article describing, with the aid of diagrams, six different methods for starting rotary converters.—Lond. *Elec. Rev.*, April 21.

POWER.

Power Transmission in France.—SOLIER.—A very profusely illustrated article on power transmission from Entraygues to Toulon, a distance of 58 km., and to a number of small plants in the county of Var. There are three 1,000-hp turbines coupled to 700-kw, three-phase generators running at 300 r.p.m. The voltage generated is 3,500, which is raised for transmission to 26,000 or 28,000. Direct current is used at Toulon at 260 volts for lighting and at 600 volts for traction.—*L'Eclairage Elec.*, April 8.

Pumping.—An article on the electric sewage pumping stations at Sydney, N. S. W. The motors, which are connected to the pumps by a double reduction gearing, are 500-volt, direct-current machines, wound differentially to give an approximately constant speed under the variations of load on the pumps, this variation being due to the difference of head when the tanks are full and when empty; the output of the motors ranges from 15 to 60 hp, the average speed being 600 r.p.m.—*Eng'ing Record*, April 29.

Power in Textile Mills.—An editorial pointing out that the margin of profit in cotton manufacturing is so small that in the consideration of costs it is generally stated that the most perfect equipment is the most economical. The necessity of using electric power is pointed out.—*Iron Age*, May 4.

Variable-Speed Motors.—A full account of a discussion held at a recent convention of the National Machine Tool Builders' Association on the application of individual variable-speed motors for driving machine tools.—*Eng'ing Record*, April 29.

TRACTION.

Motor Cars.—An illustrated description of the improvements recently made on the motor cars of the Metropolitan West Side Elevated Railway Company, of Chicago. The principal novel features are the new automatic air brake with graduated release, the wiring and the fireproofing. The general plan of wiring has been to run wires under the car in loricated iron pipe conduit. The rule has been to have no 500-volt current above the car floor, except that used on the lighting circuit, even the main circuit-breaker being underneath the car and set and tripped by a 14-volt battery circuit. The lighting circuits are laid in iron pipe conduit up to the distributing board, where the fusible cut-outs are located. The electric heating circuits are also placed in iron pipe above the floor.—*St. R'y Jour.*, April 22.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Gas Power Plant.—A fully illustrated description of the Church Stretton gas-driven electricity works. It is an example of a suction producer gas plant "which, in combination with an electrical plant, forms an ideal installation for a small and purely residential district." There are two 80-hp gas engines, running at 200 r.p.m., and driving each a 50-kw shunt-wound dynamo. Each machine is constructed for an output of 120 amp. at 400 volts. There is installed a battery consisting of 230 cells arranged in tiers, 115 cells being on each side of the three-wire system, on which the town distribution is carried out. This battery is capable of supplying 220 lamps of 16 cp for nine hours without aid from the dynamos. The connections to the battery are on a somewhat novel plan. Instead of the usual motor-driven boosters run in series with the dynamo, for charging the battery, the cells are connected in parallel with the 420-volt machines, regulating switches being provided for cutting the center cells in and out. The 420-volt supply current will charge a certain number of cells, the exact number depending on the state of charge of the battery. The remaining cells are charged by the motor-generators. By this means the battery, although always kept in circuit with the feeders, can still be charged without interfering in any way with the steadiness of the supply. With the battery-regulating switches are combined the shunt-regulating switches of the motor-

generators. The object of this combination is to keep the motor-generator current constant as the cells are cut in or out of circuit, th: resistance in the shunt winding being increased in proportion as the number of cells to be charged is decreased, and vice versa. The motor-generator consists of a 420-volt motor, with a charging dynamo coupled to either end; each dynamo has an output of 35 amp., at pressures up to 110 volts, the speed of the combined set being 1,400 r.p.m. The advantage of the suction gas producer plant is explained. The fuel used—anthracite pea coal—costs $4.75 per ton at the generating station, and the fuel cost per kw-hour amounts to 0.82 cent. The plant is as yet lightly loaded, the lamps connected to date numbering 1,053, while the plant is capable of dealing with 6,000 lights of 8 cp, allowing for 3,000 being used simultaneously. The opinion is expressed that this type of plant is likely to occupy a prominent place in the lighting installations of the smaller English towns and villages.—Lond. *Elec. Rev.*, April 21.

WIRES, WIRING AND CONDUITS.

Low-Tension Fuses.—SCHWARTZ AND JAMES.—A paper read before the Manchester Section of the British Institution of Electrical Engineers, on low-tension fuses. The curves in Fig. 3 show the

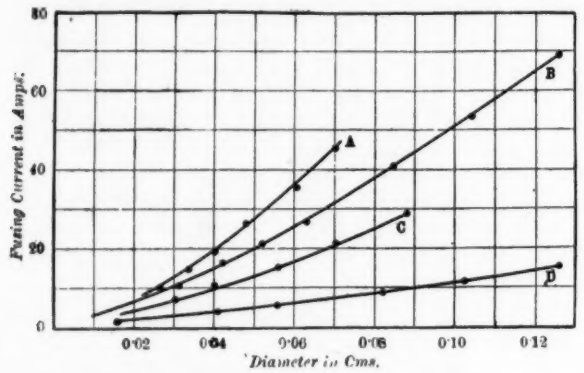


FIG. 3.—FUSE CURVES.

relation between diameter and fusing current for wires of silver (*B*), tin (*D*) and aluminum (*A* and *C*). In common with wires of lead and tin and their alloys, aluminum wires, particularly in the smaller diameters, are considerably affected as to their fusing current by the action of the atmosphere. A layer of oxide or carbonate is formed of sufficient thickness and strength to hold up the metallic core of the wire when in a molten condition. Such wires break by the molten metal draining from the upper to the lower portion of the wire, and the fusing current is consequently abnormal. This is strongly indicated by the two curves, *A* and *C*, in which *A* relates to an aluminum wire held in the ordinary way between terminals, while *C* refers to a wire placed under tension by means of a weak spring attached to one of the terminals. If an aluminum wire, supported between terminals in the ordinary way, be subjected to a current sufficient to produce the fusion of the wire, but not its rupture, and the current be then gradually reduced, the metal will remain molten even with quite a small percentage of the current originally necessary to produce fusion. This is due to the increased resistance offered by the molten metal and the greater quantity of heat produced in the fuse in consequence. As the resistance of the fuse compared with that of the whole circuit is negligible, the current flow will be the same in both cases. It is, in fact, somewhat difficult to cause the metal to solidify again, as the fuse often ruptures as the current is being reduced. For copper wires the effect of being in a vertical position instead of a horizontal one is to decrease the fusing current by about 6 per cent. for wires of small diameter with fusing currents up to 10 amp. The author gives details on fuses of tinned copper wires, copper strips, lead strips. The power lost in a fuse wire of given length will depend upon (1) the normal fusing current, which depends, among other things, upon the melting point of the metal employed; (2) the strength of the current passing through the wire; (3) the specific resistance of the metal when cold, (4) the coefficient of increase of resistance with temperature. The rate of increase with the power losses with an increased percentage of the fusing current depends to a large extent upon the last item; this is very noticeable in the case of copper. Tin is the most economical metal to use; then come silver, aluminum (with spring attachment), copper, and aluminum (without spring). Having regard to the above results, it would seem desirable to run copper fuses at 50 per cent. of their normal fusing current rather than at a higher rate. The temperature attained under normal load will then be moderate and oxidation will be slight. On the other hand, fuses rated to blow with an excess current of 50 per cent. of their normal carrying capacity get far too hot, and oxidize to such an extent as to require frequent inspection and renewal. In the opinion of the authors the normal fusing current in copper fuses should not exceed 100 amp. per wire. Fuses for larger currents should be made up of several wires in parallel, spaced about 1½ in. apart. The authors strongly favor the use of tinned copper. It is easily obtainable of constant composition. It is mechanically strong and the mass of metal required for a given carrying capacity is small. Care must be taken with the smaller sizes to see that the wire itself does not get into the thread of the terminal screws, otherwise it is easy to handle in sizes down to No. 38 S. W. G., which would be used to protect a three-amp. circuit. It does not oxidize perceptibly when carrying 50 per cent. of its normal fusing current, but at rates higher than this oxidation becomes troublesome. There is, however, no trouble from the holding up of the molten metal by the film of oxide. Unless guarded, the molten particles may, on a dead short-circuit, be scattered 15 or 20 ft., but this difficulty may be easily overcome by suitable protection. Considerable prejudice seems to exist against copper fuses on account of alleged increased fire risk. The risk of fire is three-fold. First, owing to the wire becoming red-hot prior to fusion; second, due to the scattering of the molten particles of metal, and third, owing to the formation of a persistent arc on fusion. With properly designed holders and fuse boxes, in which all inflammable material is entirely excluded from the sphere of action of the wire, the fire risk from the first two causes is practically nil, while the risk from the third cause is less with copper than with more volatile metals. Tinned electrolytic copper should be used exclusively except in the case of enclosed fuses which have been designed for use with metals of low melting point.—Lond. *Elec.*, April 21.

ELECTROPHYSICS AND MAGNETISM.

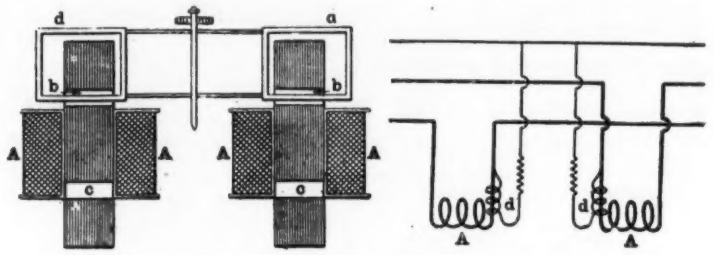
Frictional Excitement of Vacuum Tubes.—HESS.—An article describing a curious phenomenon which appears to offer a method for converting friction direct into light of a very economical kind. The author was experimenting with an electrodeless tube held in the hand and connected with one terminal of a Holtz machine, while the other end of the tube faced the second terminal of the machine. The tube thus represented a kind of Kleist jar, and on touching the free end with the free hand a shock was felt and a luminous discharge passed through the tube. This might have been expected, but the author also found that subsequently the tube could be caused to flash up by simply rubbing the hand over it. He then examined a number of vacuum vessels of all kinds, including glass spheres, Geissler tubes containing oxygen, hydrogen, nitrogen, carbonic oxide and acid, argon and helium, as well as glow lamps of various makes, and finally the Torricellian vacuum. In every case the vessel could be caused to shine out by friction only, though the first incandescence was sometimes slow in coming. At lower exhaustions, the light consists of a cloud which follows the hand, while at higher vacua a ring of light adheres to the walls and moves with the finger, or a little more slowly. Hydrogen tubes are extremely sensitive, and may be brought to shine out by means of a fine brush. The author supposes that the gas is ionized by the first friction,and is thereafter capable of discharging subsequent charges, the electrons proceeding from the walls and colliding with the positive ions at distances varying with the pressure.—Lond. *Elec.*, April 14; from *Phys. Zeit.*, April 1.

Electrons.—BUCHERER.—A mathematical note in which the author calculates the electromagnetic field of a rotating electron which plays a fundamental rôle in the theory of magnetism.—*Phys. Zeit.*, April 15.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Recording Alternating-Current Wattmeter.—OLIVETTI.—With reference to a recent paper of Sumpner the author states that he has constructed alternating-current wattmeters in which iron is used lavishly. Yet these instruments are said to be independent within wide limits of the frequency and wave form. Figs. 4, 5 and 6 show a recording wattmeter for unbalanced three-phase circuits. It is a combination of two single-phase wattmeters, each electrically independent of the other, but mechanically connected. The field magnet,

A, of each wattmeter produces a flux in the laminated iron core. There are two air-gaps, *b* and *c*, in the magnetic path, the length of the upper gap, *b*, being about one-twentieth that of the entire magnetic circuit, while *b* and *c*, together, are about one-twelfth of the



FIGS. 4 AND 5.—ALTERNATING-CURRENT WATTMETER.

same length. These lengths of air-gap have been found most suitable for obtaining a uniform field, an important condition in recording instruments. Coil *d* is the shunt coil, one side of which swings in the upper air-gap. It is mechanically connected, in the manner in-

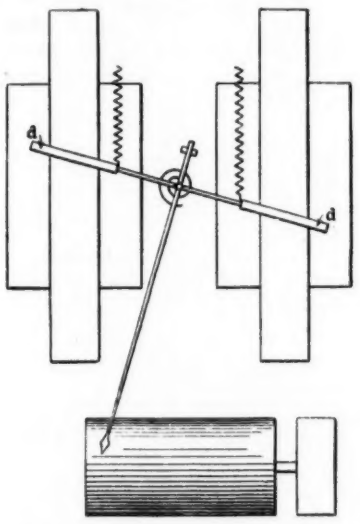


FIG. 6.—ALTERNATING-CURRENT WATTMETER.

dicated, to another shunt coil, *d*, swinging in the upper air-gap of the second wattmeter. The electrical connections of the complete wattmeter are also shown.—Lond. *Elec.*, April 14.

Electrical Standards and Units.—A very long discussion was held by the British Institution of Electrical Engineers on electrical standards and units, with special reference to the deliberations at the St. Louis Congress. Duddell, Gray, Rayleigh, Ayrton, Trotter, Smith, Glazebrook, S. P. Thompson, Crompton, Harrison and Crawley participated in the discussion. The main topics were the uniform adoption of standards and the "rationalization" of our electrical units. No vote was taken.—Lond. *Elec.*, April 14, 21.

Two-Wattmeter Method.—LEGROS.—The first part of a mathematical article on the application of the two-wattmeter method in three-phase systems. If the power of a three-phase system is measured in this way, the reading of the instruments can be utilized for calculating the power factor. The author investigates the influence of the higher harmonics of the tension and the current curves, on this determination in different cases.—*L'Eclairage Elec.*, April 15.

Oscillographic Wave Tracer.—GOLDSCHMIDT.—An illustrated description of a new instrument for tracing current waves. The alternating current is sent through two solenoids, c_1c_2 (Fig. 7), which are placed opposite to one another on either side of a steel needle. In consequence of the attraction and repulsion exercised by the alternating solenoids on the free end of the needle (*s*), the latter oscillates, and if it is light enough its deflection will follow closely the impulses it receives through the alternating current. The top face of the needle being polished, a ray of light reflected from it will describe a curve if thrown on a rotating mirror or a moving film band. However, in order to avoid the complications involved in a rotating mirror, the author has devised a modification of this arrangement in which the curve is obtained directly on a fixed screen. This is achieved, as shown in Fig. 8, by a second pair of solenoids, c_3c_3, the axis of which is at right angles to that of c_1c_1. These latter solenoids are excited from the same alternating source, but while c_1c_1 have a non-inductive resistance, *R*, in series with them, c_3c_3 are coupled in series with a choking coil, *T*. Through the influence of both these sets of alternating coils a double movement of the needle is obtained, the movement in direction *v* representing the voltage and the movement in direction *t* representing the time. We may, therefore, call c_1c_1 the volt coils and c_2c_2 the time coils. The choking coil, *T*, in the time coil circuit has a double effect: (1) It displaces

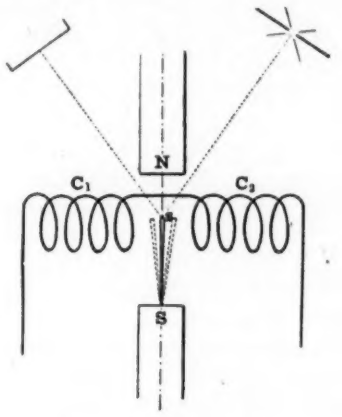


FIG. 7.—WAVE TRACER.

the phase of alternating current in the time coils about 90° behind the phase of the current in c_1; and (2) it purifies the current in c_3 by filtering out higher harmonic waves, so that this current is prac-

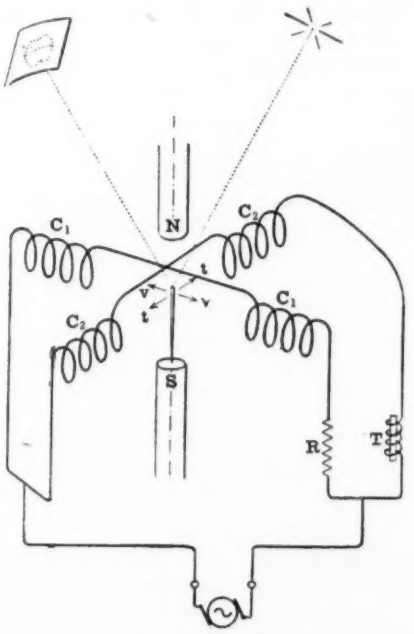


FIG. 8.—WAVE TRACER.

tically sinusoidal, independent of the e.m.f. wave form. But this sinusoidal is not quite what is necessary for the deflection in the direction that ought to be directly proportional to the time. To obviate this difficulty the screen is given a semi-circular form, whereby the time error is rectified, and the abscissæ as seen on the screen are a proper measure of the time. Besides this, other means have also been adopted for correcting the time error; for instance,

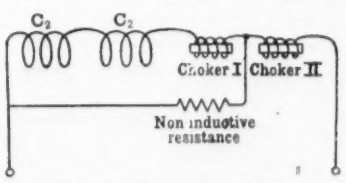


FIG. 9.—WAVE TRACER.

by a specially shaped mirror or lens, or by influencing the magnetic field itself in the direction of the time coils by two small iron pins fixed on either side of the pole, *N*. The needle can be kept very short (actually about ⅛ in.) and by means of a strong continuous-current magnetizing force the controlling power can be made so high

that the periodic time of the needle can be kept below 1/5000th of a second, so that the apparatus is suitable for most industrial purposes. The necessary damping which prevents overshooting of the needle is effected by the eddy currents produced in pole N by the movement of the needle itself. It is important to obtain, as nearly as possible, 90° phase displacement between the currents in c_1 and c_2; therefore, there is used in the circuit of c_2 not a choking coil, but, as shown in Fig. 9, a combination of two choking coils and a non-inductive resistance.—Lond. *Elec.*, April 14.

Measuring Wave Lengths.—DRUDE.—A long article describing methods of calibrating instruments for measuring wave lengths, especially for calibrating Slaby's so-called multiplication rod with which resonance is produced with a coil of variable length.—*Elek. Zeit.*, April 13.

Cymometer.—FLEMING.—An abstract of a British Physical Society paper on the application of the cymometer to the measurement of coefficiencies of coupling of oscillation transformers. The cymometer is an instrument designed by the author for the measurement of the frequency of electric oscillations, and also the length of long electric waves.—Lond. *Elec.*, March 31.

Electricity Meters.—GERHARDI.—A continuation of his illustrated serial on electricity meters. He describes the O. K. ampere-hour meter and the Reason meter, the later being an example of the mercury type of motor meter, and cheaply made as a prepayment meter. —Lond. *Elec.*, April 7. In continuations of his serial he describes the Wright electrolytic meter, and then passes over to the discussion of meters suitable for both alternating and direct current. After some general remarks on meters of this type, the Thomson meter is described.—Lond. *Elec.*, April 14 and 21.

Spark Transformer.—WALTER.—A description of a transformer devised as a substitute for the induction coil in exciting Röntgen ray tubes. The leading characteristics of the transformer are the large number of turns in the secondary and the closed magnetic core.—Lond. *Elec. Rev.*, March 17.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone Exchange.—An illustrated description of the new telephone exchange at London Wall. The new exchange has been erected on modern lines, the Western Electric Company's central battery system being employed. The most prominent feature, however, is the arrangement of the switchboard in tiers. This system had to be adopted in the old exchange owing to the shape of the building, and it has of necessity been used again in the new one. The switchboard itself is on three floors, the bottom tier being the second floor of the building and the others being galleries. On the first floor are the intermediate distributing frame, the line relay racks, etc. On the ground floor the test jacks and main distributing frame are placed, and in the basement is the power plant.—Lond. *Elec.*, April 21.

Signaling in War Service.—SULLIVAN.—An illustrated account of the use of the telegraph and the telephone by the Japanese in the present war.—*Cassier's Mag.*, April.

MISCELLANEOUS.

Unsolved Problems in Electrical Engineering.—CROMPTON.—A lecture discussing a few of the most prominent unsolved problems in electrical engineering. He divided them mainly into two great classes: those set by Nature herself, and those which have appeared in a process of evolution due to the advances made by workers in the sciences of electricity and engineering. Prominent in the first category comes the phenomenon of lightning discharge. "Etheric" transmission of power is then discussed, being another fascinating subject, in spite of the fact that its application is at present limited to telegraphy. The speaker seemed to hold the opinion that no great advances will be made in this direction until it is possible to construct an alternator or some similar machine with a frequency in the neighborhood of 1,000,000 per second, so as to secure a series of continuous discharges of high power. Speaking of the dynamo, he dealt with one feature of dynamo design only, and called it the problem of the "core and coil," otherwise the field magnet and its winding. He referred to the fact that the addition of silicon to iron renders the latter more fusible and free from blow holes. Referring to Hadfield's aluminum-copper-manganese magnetic alloy, the lecturer suggested that this may contain the whole secret of magnetism; if this be so, then no effort should be spared to prosecute research in magnetic alloys, for it is just conceivable that experiment may lead to the discovery of a material possessing a permeability higher even than iron. To obtain an impregnating material which will stand temperatures much higher than the customary limit in dynamo electric machinery may soon no longer be among the "unsolved problems." In speaking of accumulators, he condemned the use of end cells. He suggested a combination of the internal combustion engine with a suction gas plant worked for long hours for charging batteries sufficient to deal with the bulk of the load, but supplying the short hours of peak load by steam plant specially designed to work for short hours at a maximum efficiency. From the development of large power schemes with distribution over extended districts, he hopes will result a decentralization of industries.—Lond. *Elec.*, April 14.

Electrotherapeutics.—A note stating that in the annual report of the Nottingham general hospital, Dr. Jacobs says that during the past two years 56 patients suffering from lupus were treated, of whom 24 were cured and the remainder are improving. There were 19 cases of rodent ulcer, of which 10 were cured and 7 are improving. Many forms of skin disease were dealt with, and in the majority of cases the results were quite satisfactory. Radium has proved of considerable service for the treatment of disease in parts of the body inaccessible by any other means. In some forms of rodent ulcer its effects were extremely good. The total number of patients treated in this branch of the electrical department during 1904 amounted to 147, and at the present time there are 50 cases under treatment. In addition to these 168 patients who received injuries to the joints were treated by means of the radiant heat bath, and most of them have been benefited greatly.—Lond. *Elec.*, April 21.

Manufacturing Plant.—An illustrated description of the workshops of Elliott Brothers at Lewisham, makers of electrical, optical, engineering and mathematical instruments. Electricity is used throughout for illumination and power.—Lond. *Elec.*, April 14.

BOOK REVIEWS.

THE CREDIT MAN AND HIS WORK. By E. St. Elmo Lewis. Detroit, Mich.: The Bookkeeper Publishing Company. 360 pages. Price, $2.00.

When it is remembered that 90 per cent of the world's trade is carried on credit, the importance of care in granting credit becomes evident. Fundamentally, business is based upon honesty, and if all men were equally honest there would be no need of credit systems. But since these desirable conditions do not exist, the protection of business interests against the results of the folly, carelessness and dishonesty of men has become necessary.

This work is treated from the business man's standpoint, and not from the standpoint of the theorist, and is for this reason of more practical value. It begins with a history of credit, in which the author deals with the rise of the credit transaction, following it step by step to the modern commercial credit. Proceeding with the development of the subject, the author shows what influence "The Character of the Business," "The Character of the Management," the "System of Organization," "Competition," "Business Methods," and "Accounting Methods" have upon the value of a risk, in compromising the value of marketable commodities. Other chapters are devoted to "The Balance Sheet," "Capital and Resources," "Credit Indemnity Insurance," "Cost of Production," as applied to determining valuations and profits; two chapters to the systems for collections and credit information, four to the legal side of the credit man's work and the remainder of the 25 to other features of the general subject.

The information contained in this work will fit any line of business, and should serve a very useful purpose.

DAS ELEKTRISCHE BOGENLICHT. Vol. I. By W. B. Von Czudnochowski. Leipzig: S. Hirzel. 98 pages, 14 illustrations. Price, 3 marks.

This book of 91 pages covers a much larger field than the title indicates. A more appropriate title would have been "Artificial Light; Its Development and Physical Foundation."

Very appropriately, the book has been dedicated to Friedrich von

Hefner-Alteneck. It has much valuable information for the original investigator of any artificial source of light and would appeal especially to physicists.

In his introduction the author compares the distribution of gas from a central station with that of electric light from an economic point of view, then presents the historic development of the electric arc, and in a short summary contrasts the fruitful efforts of the last century with all the artificial sources of light produced during all the centuries up to the nineteenth.

After a short reference to petroleum, alcohol and acetylene light, the reader is taken back to the electrical field. The Nernst, osmium lamp, electrolytic and mercury arc light are touched upon, and some of the advantages of electrical central station distribution over gas distribution are enumerated.

For the understanding and determination of the propagation of light, the ether theory is used and the works of Cassini, Roemer, Huyghens and others are referred to. In connection with the propagation of electricity the works of other familiar men of science are referred to; for instance, those of Watson, Wheatstone, Weber, Kohlrausch, Faraday and Maxwell and Hertz.

The author then takes up the subjects of the continuous and discontinuous spectrum, primary and secondary sources of light and intensity of illumination, as well as the units or standards of light, which are enumerated in chronological order. The construction of the Hefner lamp and its use are given in detail, followed by various methods and photometers for measuring and comparing different sources of light.

By means of tables and curves, the variations of surface illuminations are presented, and the mean spherical and hemispherical intensities are calculated. Further means of light diffusion as well as light concentration are considered in connection with lighthouses and other special installations.

In tabulated form the author presents the heat generation and power consumption of light sources, to which is added a discussion of the mechanical equivalent as well as a description of apparatus for the quantitative determination of this mechanical equivalent.

A very instructive table shows, for instance, that from a standpoint of efficiency the Geisler tube is the best source, although but 33 per cent. of the energy supplied is changed into light. In the average arc lamp only 10-16 per cent., in the incandescent lamp but 6 per cent., acetylene only 5.5 per cent. and with the various types of gas burners the amount of energy changed into light varies from 1.28 to 4 per cent. of the total energy supplied; that is to say, into rays susceptible to the human eye.

In accordance with the importance of the subject the author gives a considerable amount of space to the determination of the mechanical equivalent of sources of light and points out two important problems. One is the determination of an absolute mechanical equivalent of light. The second is the finding of a more efficient source for the production of light which would be had by finding a body which will withstand 6,000° without great deterioration, emitting rays of the length susceptible to the human eye. Over 200 titles of works on kindred subjects conclude this interestingly written work.

ELECTRIC MOTORS. By H. M. Hobart. New York: The Macmillan Company. 458 pages, 480 illustrations. Price, $5.00.

This treatise deals with both direct and alternating-current motors, and is essentially a textbook on design. The causes of sparking in direct-current machines are discussed at great length, and the author expresses the opinion that the best way of designing motors with a certainty of satisfactory commutation is altogether to abandon dependence upon electromagnetic assistance in reversing the current in the coil undergoing commutation under the brush, and to rely upon having such proportions that the reactance voltage in the short-circuited coil has, at full load, such a low value as in itself to insure freedom from sparking. Very valuable suggestions are made as to the method of determining the reactance voltage, an example of the proper calculations being given as a guide. Such a method of design is safe, but would seem to require a much more expensive commutator construction than is generally customary. Strangely enough, no mention is made of over-compensation of the magnetomotive force of the armature current as a method of insuring satisfactory commutation. The book contains a very large amount of valuable information concerning the constructive details and test data of many types of direct-current motors. It is this information arranged in such convenient manner which gives to the book its peculiar worth. Much space is devoted to variable-speed, continuous-current motors and methods of control, the double-commutator, series-wound motor for traction being treated most thoroughly.

Under alternating-current motors only the polyphase induction machine is described, but the treatment of this motor both as to performance and design, is quite complete when one considers that a consistent effort has been made to eliminate all mathematical equations and to deal with the phenomena by means of vector diagrams. The simple circle diagram without complicating auxiliary lines is given well-deserved prominence. A noteworthy feature of the book consists in the numerous examples of induction motor design with all mechanical, electrical and magnetic proportions completely calculated. The designs cited represent modern European practice with such machines.

Although commutator types of alternating-current motors are omitted entirely in the descriptive matter of the book, there is given a comprehensive bibliography relating not only to single-phase commutator motors, but to the subject of the employment of commutators in alternating-current machinery in general, the two subjects being practically inseparable. In the preparation of the present volume the author has sustained his well-deserved reputation of being a clear and concise writer who supplements his statements as to proper methods of design by examples from the best practice of the day.

ELECTRIC LIGHTING. A Practical Exposition of the Art. By Francis B. Crocker, Ph.D. Sixth Edition. New York: D. Van Nostrand Co. 482 pages, 213 illustrations. Price, $3.00.

This sixth and latest edition of "Electric Lighting" has been much enlarged and largely rewritten. The main character and classification of the first edition have, however, been retained, but somewhat more attention is given to alternating currents. The style is clear and forceful. The matter is eminently practical and adapted to the needs of men who wish to acquaint themselves with the standard methods for installing and maintaining electric lighting plants. There is very little algebra in the book, but there is much useful and quantitative information.

A good deal more attention is given to the buildings and engines for a lighting plant than usually appears in books on the subject. The steam turbine, for example, receives special consideration. Special chapters are also devoted to the practical management of dynamos, storage batteries, switchboards and lightning arresters. The book freely employs both the English and metric units, as well as conversion tables for passing from one to the other.

Preparing for Warm Weather in Boston.

The Edison Electric Illuminating Company, of Boston, is extensively advertising this month three devices of interest in reference to the coming warm season: the fan motor, an artificial refrigerating machine and an electrically-operated carpet cleaner. The company points out that fan motors have now become a necessity in the home as well as the office; that electrical ventilation is no longer a luxury, as it was considered a few years ago; and that the fan motor has been found useful in cold weather as well as hot, namely, to keep the frost off the windows, to distribute heat from radiators so as to give a much more uniform and even temperature throughout the room, and to assist materially in drying the laundry. The company states that in several cases which have recently occurred where goods had been washed indoors, and where there was the necessity for drying without being exposed to the outer air, electric fans were pressed into service and accomplished the desired result in an amazingly short time.

The annual spring house-cleaning is robbed of many of its annoyances by the use of a vacuum carpet cleaner operated by a 3-hp motor. This machine is capable of extracting every particle of dirt and dust from carpets and rugs, and can also be used to clean bare floors and walls, draperies, upholstery, etc. The exhaust pump of the machine creates a vacuum of from 24.5 to 30 in. of mercury, which is applied directly to the work through a hose and slotted scraper, the dirt and dust being drawn away and deposited in a receptacle ready to be thrown away. By this method the dirt and dust are permanently disposed of with much less wear and tear on the

article cleansed than the old methods of sweeping and beating, and the accumulation of dirt is not stirred up and scattered through the air only to settle again on the very objects cleaned.

The company also points out the increasing interest of the public in the subject of artificial refrigeration during the past few years. It states that although the practicability of such work on a large scale has been repeatedly demonstrated, it is only within the last two or three years that the small refrigerating machine suitable for use in the household has attained a satisfactory position. The company has on exhibition a small refrigerating plant of 200 pounds ice-making capacity per day, driven by a ½-hp motor on an ordinary lighting circuit, and so well adjusted as to be practically noiseless in operation. The company emphasizes the advantage of obtaining a uniform temperature with a thoroughly dry box, thus avoiding the disadvantage of using ice, and the discoloration of water, etc., by the moisture in the box. The expense of operating such a machine is very much less than the cost of ice; there is no tracking of muddy boots and dripping clothes through kitchens, and the melting of ice is entirely obviated.

Gasoline-Electric Motor Car.

The St. Joseph Valley Traction Company has recently placed in service an interesting type of car for interurban service, which is now in active use between La Grange and Middleboro, Ind. The car is equipped with a Walrath gas engine driving a generator which supplies current to four car motors, a storage battery being also used for supplying power during periods of acceleration. The car is 34 ft. long over end sills, and is divided into two compartments, an engine room and baggage room. The width over side sills is 9 ft. 8 in. The trucks are the heaviest street railway trucks with 33-in. wheel. The motive power is derived from a four-cylinder Walrath gasoline engine, which, under factory tests, developed 70 hp at 325 r.p.m. with a consumption of one pint of gasoline per hp-hour. The cylinder jacket water is kept in constant circulation by means of a rotary pump belted to a pulley on the engine shaft. The cooling of the jacket water is effected by circulation through 800 ft. of ¾-in. automobile radiator pipe, and thence through a supply tank of 190 gals. capacity. The radiation of heat is rendered more effective by a blast from two 42-in. fans revolving in a horizontal plane at the rate of 300 r.p.m. directly under the radiator and exhausting the air through ventilators in the upper deck.

The engine is direct-connected to a Sprague 50-kw, 250-volt, direct-current generator, which supplies current to four motors mounted upon the trucks. To provide for the heavy load which is thrown upon the generator for an instant, due to accelerating the car in starting, a battery of 120 "chloride" storage cells are installed. The 120 cells connected in series give a difference of potential of 249.6 volts at the terminals of the battery. The cells are placed in well ventilated lockers painted internally with asphaltum paint. The gases arising from the battery are drawn from the lockers and exhausted through the ventilators by the previously mentioned fans.

The leads from the battery are carried to a switchboard of special design, and there connected in multiple with the generator leads to the main controller leads. In this method of connection it is evident that when a heavy pull comes upon the generator and its voltage drops below that of the battery, the load is divided between them, and vice versa, when the load does not require the total output of the generator the excess current is utilized in charging the battery. Circuit-breakers capable of adjustment for a series of amperages are connected in the battery and generator leads to the switchboard, to obviate the necessity of replacing blown-out fuses.

In addition to the traction load the generator supplies current for a 4-hp motor-compressor connected with the air-brake system, current for lighting purposes and for a small storage battery used in the gas engine ignition. The car is equipped with an automatic air-brake system, and also a hand-brake rigging. The gasoline supply is carried underneath the car in a heavy galvanized iron tank of 125-gal. capacity. The supply of gasoline to the engine is fed by a small reciprocating pump. The supply is always greater than that required by the engine, and the excess gravitates back to the reservoir through an overflow pipe.

Two methods of starting the engine have been provided, either of which may be used independent of the other. The first method is that of driving the generator as a motor for the storage battery until the gasoline is working normally through the engine. To accomplish this end, the field leads from the generator, instead of being run directly to the field rheostat, are led through an intermediate switch upon the board. By throwing this switch the field of the generator may be connected with a storage battery and fully excited. Then by means of a single-pole, four-point switch connected with a series of resistances, current may be gradually introduced to the armature, when the generator will start as a motor.

GASOLINE-ELECTRIC MOTOR CAR.

As soon as the engine takes hold of the load it is only necessary to throw the field current back under the control of the rheostat.

The second method is that of driving the engine pistons by compressed air until the gasoline works normally through the engine. For this purpose an air compressor is belted to a pulley on the engine shaft. This compressor has a capacity of 5.9 cu. ft. of free air per minute running at 165 r.p.m., and maintains a pressure of 200 lbs. per sq. in. in two cylindrical steel reservoirs. These reservoirs are also connected with the reservoirs of the air-brake system (where a pressure of 90 lbs. per sq. in. is maintained) through a reducing valve, so that in case the motor compressor should become disabled the air-brake system could be operated.

The mechanical and electrical equipment of this car occupies 33 per cent of the floor space of the car, and aggregates a weight of about 5 tons. The car was designed for efficient interurban service, and is at present in daily operation, making four trips a day between La Grange and Middleboro, Ind. The St. Joseph Valley Traction Company has expressed itself as being very highly pleased with the equipment. On the trial run, which was made over the Chicago Terminal Railroad Company's right of way, between Chicago and Harvey, Ill., a speed of 26 miles per hour was obtained with ease, when pulling the private coach of the Chicago Heights Terminal Railroad containing about 40 passengers.

We are indebted for the above information to the MacKay Engineering Company, of 149 Broadway, New York, the Eastern agents for the Marinette Gas Engine Company, makers of the Walrath gas and gasoline engines.

Electrical Exhibits at the International Railway Congress.

Technical and industrial conventions in this country have been accompanied by expositions of appliances and material for many years past, but it may be stated without any fear of contradiction that the display at Washington during the current two weeks, May 1-14, has marked the height of effort and achievement in this particular direction. Many conditions have conspired to bring about the result, but first and foremost has been the importance of the occasion, and, secondly, has been the prominence and rank of the delegates from all parts of the world. Next may be suggested the fact that the convention is held in the city of Washington under the official approval of the United States Government, something that weighs considerably alike with the foreign visitor and the domestic exhibitor. This rational co-operation is evidenced by the passing of a special act of Congress permitting the exhibit to be made in the park and on the mall, immediately adjoining and surrounding the Washington Monument, where an embryonic or miniature World's Fair has been created. Monument Park has for the time being become a transportation building, and if anything relative to the art has been missing it has not yet been noted. The area of several acres, enclosed by wire fence, is dotted with elaborate white wooden structures of individual exhibitors, arranged in rows and surrounding a large main exhibit building, all being brilliantly illuminated at night by numerous arc lamps and thousands of incandescents for service and decoration. The total cost of such an exhibit it would be hard to determine, but some criterion may be formed from the reports current that on the largest exhibit of all—the splendid display under the all-powerful name of Westinghouse—not less than $25,000 has been spent. Of this exhibit some note was made in our columns last week; it is further referred to elsewhere. No small amount of credit is due to Mr. George A. Post, chairman of the general committee of arrangements of the Railway Appliance Exhibition, and to Mr. J. A. Brown, secretary and director of exhibits, on the success of their work. No fewer than 370 firms and individuals have thus exhibited under their management.

The opening exercises of the exhibition were held on May 3, when Mr. George Westinghouse presided, and was most enthusiastically received. In the course of his remarks he said: "A new era of railway operations has dawned, with its many new problems. I refer to the growing use of electricity for the movement of trains. There have already been such demonstrations of the benefits to be derived from the substitution of the electric motor for the steam locomotive that it requires no great prophet to predict the extensive growth of electric traction upon the great railways of the world and the eventual replacement of the steam locomotive. Fortunately, the time element, which is such a controller of events, and the financial problems involved, will insure gradual development and extension of the use of electricity."

Mr. Stuyvesant Fish also spoke and said: "One thought has been before me in this connection, which is that we are going through a period here to-day with regard to electricity precisely such as was gone through 100 years ago with regard to steam. We are at the beginning of it as an application to locomotion; the principles are being studied and devised; you will see them here. The thing is on the threshold of being accomplished, as 100 years ago Fulton's practical steamboat was about at its conception. And as we now look back at the names of Whitney and of Fulton, those who come after us will look back upon the names of the inventors of this day—our distinguished chairman, whom I will not name again, although it would be a pleasure to do so—and they will look back upon Bell, they will look back upon Sprague and Edison. As we look back upon the pioneers and inventors of steam applied to locomotion, so they will look back upon the pioneers of electricity applied to locomotion as one essential of civilized life."

A feature of the opening of the exposition was the sending of a time signal around the world, under the auspices of Rear Admiral Chester, U. S. N., superintendent of the United States Naval Observatory, and through the arrangements of Mr. W. F. Allen, American secretary of the congress. These gentlemen were assisted in every way by President Clowry, of the Western Union Telegraph Company, and Vice-President Ward, of the Commercial Cable Company. A huge map, on the grounds, was lit up by 200 incandescent lamps, showing the leading cities of the world, and these lamps flashed into circuit as the message sped in less than ten seconds over the 500,000 miles of circuit and cable of "Puck's Girdle." The method of signaling was thus explained by Admiral Chester: "The electric connections of the Naval Observatory clock are arranged to omit the twenty-ninth and the last five seconds of each minute, and finally the last ten seconds of the last minute. Beginning at 11.55 p.m. the lights in North America and across the Pacific to Manila will be illuminated automatically every second, representing the practically instantaneous delivery of the signals to that great region. The first flash after each short break marks the thirtieth second and the first after each five seconds break marks the sixtieth second. Finally, after the last and ten-second interval a long flash will mark the exact instant of midnight, and this long flash will spread quickly over the map, exactly as actual observation has shown that it passed along by thousands of operators, through hundreds of thousands of miles of wire, over continents and under oceans,

A brief description of the chief exhibits of interest to our readers is appended:

ELECTRO-DYNAMIC COMPANY.—The Electro-Dynamic Company, of Bayonne, N. J., as noted last week, occupied spaces Nos. 1 and 2 in Section O in the main exhibition building, and showed there one of its type 5-S four to one inter-pole, variable-speed motors, belted to a generator, illustrating the perfect operation of its inter-pole motor under varying conditions of speed from 275 r.p.m. to 1,100 r.p.m., and all loads from no load to 100 per cent. overload. This motor reversed freely under all of the above conditions of load and speed. The company also had on exhibition frames of different sizes of its motors running from 1 hp at a speed ratio of 4 to 1 up to 10 hp, at a speed ratio of 4 to 1; also constant-speed motors from 1 hp to 30 hp. The motors on exhibition covered 123 distinct varieties. The Electro-Dynamic Company is rapidly enlarging its scope of operation for the inter-pole motor, and furnishes at least 200 varieties of constant and variable-speed motors running up as high as 150 hp. In addition to the above exhibit one of the company's 5-S variable-speed motors, having a speed ratio of 4 to 1, operated the electric car lighting equipment of the Consolidated Railway Electric Lighting & Equipment Company. Another motor, with a capacity of 10 hp at a speed ratio of 2 to 1, drove a vertical turret lathe in the exhibit of the Bullard Machine Tool Company. The exhibit of the Electro-Dynamic Company was indicated by the large electric sign reading "Inter-pole." The exhibit was under the competent direction of Messrs. H. McL. Harding, G. H. Condict and T. B. Peck, Jr.

PRIVATE CAR "ALABAMA."—One notable "track" feature was the handsome private coach "Alabama," designed and built by the St. Louis Car Company for President H. E. Huntington, of the Pacific Electric Railway Company, Los Angeles, Cal. This car embodies some decided innovations which bid fair to mark a new era in passenger car construction for high-speed service. The framing is all steel and the construction has created a great deal of interest in railway circles. All of the work has been done at the shops of the St. Louis Car Company by the regular force of employes. The length over the bumpers of this car is 63 ft. 1 in., its total width 9 ft. 6 in., and its height from the underside of the bottom framing to the top of the roof 9 ft. 11 in. The coach is mounted on the St. Louis Car Company's No. 32 Hedley motor trucks and will be equipped with four 200-hp Westinghouse motors. The total weight, including the operating equipment, is 103,000 pounds. It has many novel features, including two open fireplaces, with McElroy coil electric heating devices. The kitchen also has an electric cooking plant.

NILES-BEMENT-POND.—The Niles-Bement-Pond Company, of New York, exhibited in Section S of the main exhibition building, the entire section being required to contain them. The apparatus shown included a 42-in. Pond planing machine, motor driven; 42-in. Pond standard lathe, motor driven; 37-in. Niles boring mill, motor driven; 400-ton Niles hydraulic wheel press; 1,100-pound single frame steam hammer and an 18-in. slotting machine. The Pratt & Whitney tools included a 2-in. x 26-in. new model turret lathe, with locomotive outfit; 14-in. engine lathe; 6-in. x 14-in. threading milling machine; 24-in. standard measuring machine, and a large variety of standard gauges for couplers, knuckles, flange thickness, locomotive and car wheels, etc. The company also showed the large case which was exhibited at St. Louis with a full line of Pratt & Whitney small tools, including taps, dies, reamers, ratchet drills, milling cutters, lathe tools and other tools presented in its small tool catalogue. In

addition to the above the company had installed in the Westinghouse exhibit the following tools, which operated by electricity; Niles new extra heavy 90-in. driving wheel lathe, and Niles No. 3 double axle lathe. It is somewhat unusual to place as heavy a machine as the driving wheel lathe in an exhibit of this sort, as there were no facilities for erecting other than the temporary structures, and the company had no little difficulty in assembling the machine. All went well, however, and the big tool attracted universal attention. The exhibit was in charge of Messrs. McKinney, Wood, Teas, Hageman, Clark, Lewis and Riker.

STANDARD PAINT.—The Standard Paint Company's exhibit embodied a reproduction of the Pennsylvania Railroad round house at Chicago, covered with Ruberoid roofing. This building was complete in every particular, 14 ft. long by 7 ft. deep. It was intended to demonstrate the utility of Ruberoid roofing as a covering for railroad round houses. In addition the company had at Washington exhibit models of refrigerator cars, showing the application of Ruberoid car roofing and of Giant insulating papers. There are also models of steel dump cars, showing the application of Flexite, the company's paint for these cars, and a model bridge to suggest the use of Standard Paint Company's colored paints for bridge work and general structural iron work. The Standard Paint Company has gone extensively into the field of colored preservative paints. The company was represented by Messrs. R. L. Shainwald, J. N. Richards, P. M. Wade, C. Earnshaw and J. H. Thomas.

LODGE & SHIPLEY.—The Lodge & Shipley Machine Tool Company, of Cincinnati, Ohio, exhibited a 24-in. x 12-ft. head engine lathe, direct-driven by an 8-hp, 220-volt Bullock motor, with a speed variation of 475 to 850 r.p.m. The motor was mounted on an extended cabinet leg at the head of the lathe and connected to the spindle through gearing at the back of the headstock. Owing to the increased size of motors, made necessary by present-day tool steel, this system is particularly advantageous, in that it places the motor where it is readily accessible to the operator, and also eliminates the top-heaviness and vibration, which would necessarily ensue were it mounted on top of the headstock. Changes of speed are secured both by electrical and mechanical means. The electrical changes are made by varying the amount of resistance in the motor field through the controller at the front of the lathe. This controller is connected by sprockets and chain, and splined rod to the lever at the right-hand end of carriage. The mechanical changes are six in number. The motor shaft is connected to a short-splined driving shaft at back of headstock, upon which is mounted a sleeve carrying two gears of different diameter. Either one of these can be engaged with the main driving gear of the headstock, providing two changes of speed. As the lathe is double-back geared, the combination provides in all six speed changes. The number of points in the controller is 20, so that in each range there are 20 intermediate speeds, or a total of 120 spindle speeds in all.

WILLIAMS, BROWN & EARLE, of Philadelphia, made an exhibit of their continuous electrical blue-printing machines, and their blue-print washing and drying machine. These were operated separately or geared together so as to wash and dry a continuous blue print of any length. The results obtained were very interesting.

PEERLESS RUBBER.—The Peerless Rubber Manufacturing Company exhibited a line of high-grade mechanical rubber goods for railway purposes, including air brakes, steam, suction and hot-water tank and washout hose, rubber belting; a full line of packings, including "Rainbow" sheet and flange packing and "Peerless" piston and valve rod packing; tubing for pneumatic tools, mats, matting, sheet tiling, etc. This enterprising concern was represented by Messrs. C. H. Dale, E. J. Courtney, C. S. Prosser and F. O. Donnell.

SOUTHERN POLES.—The Southern Exchange Company, of New York, had its exhibit in plot No. 3, in the center aisle of the grounds, next to the Westinghouse Electric & Manufacturing Company. It consisted of long leaf yellow pine octagonal and square poles, Southern white cedar poles and Georgia long leaf yellow pine cross arms, insulator pins and glass insulators. The company represented also E. P. Morris & Co., of New York, in iron brackets and pole hardware. Its officials present were Walter E. Mitchell, manager sales department; E. G. Chamberlin, New York manager, and A. J. McKinnon, vice-president and treasurer.

NATIONAL STORAGE BATTERY.—The National Battery Company, of Buffalo, N. Y., had no exhibit of its own, but supplied batteries to the Chicago Pneumatic Tool Company and the General Railway Signal Company for service in connection with their large exhibits.

CONSOLIDATED CAR HEATING.—The Consolidated Car Heating Company, of Albany, N. Y., had, in a fine separate building, an exhibition of a complete line of couplers, traps, valves, drums, fittings, etc., for direct steam and hot-water heating systems for steam railroad service. For interurban, elevated and surface electric cars various types of electric heaters were shown, in all of which the heating element is made up with the McElroy spiral coil construction. Electric heaters of this type have been in constant and successful operation during the past twelve years. A full line of regulating switches was shown in connection with the electric heaters. The McElroy automatic axle lighting system, manufactured by the Consolidated Car Heating Company, was shown in operation. This system has been in successful operation during the past three years. The company was represented by Messrs. C. S. Hawley, J. F. McElroy, F. C. Green and W. H. Fulton.

ROBINS CONVEYORS.—The Robins Conveying Belt Company, of New York, made an exhibit of its coal-handling machinery. Three conveyors were shown, viz.: One 16-in. wide by 27-ft. centers, one 16-in. wide by 26-ft. centers, and one 16-in. by 45-ft. centers. All ran at a speed of about 200 ft. per minute and required 5 hp to drive them. The first conveyor was equipped with one of the company's automatic self-reversing trippers. The conveyors were in operation, and the material was automatically distributed in the hopper by means of the tripper just mentioned. From this hopper it was discharged upon conveyor No. 2, which elevated, conveyed and discharged it into the chute which delivered to conveyor No. 3. Conveyor No. 3 carried the material to a chute which took the place of the weighing device, and which in turn discharged on to the tripper line. Conveyors Nos. 2 and 3 ran at an upward inclination of about 20½°. The company was represented by Messrs. T. Robins, A. B. Brool, Jr., and Bert Stadelman.

JOHNS-MANVILLE PRODUCTS.—The Johns-Manville Company, of New York, distributed a new publication on asbestos and magnesia railroad supplies. This booklet is divided into sections describing respectively material for the motive power department, the train service department, shops, buildings, round houses and maintenance of way, refrigeration. The company also announced that it has recently completed a large plant for the manufacture of carbonate of magnesia, and is prepared to furnish a complete line of steam pipe and boiler coverings, etc., composed of carbonate of magnesia combined with asbestos fibre. In Section G it had a fine display of all these materials under the efficient direction of Messrs. J. E. Meek and J. C. Younglove.

BROWN BONDS.—The separate exhibit of Harold P. Brown was located in Plot 4. Various types of electric rail bonds were shown, especially those suitable for steam roads which may equip for electrical operations, as well as a new method of obtaining high temperatures for brazing or soldering heavy pieces of metal together for applying electric bonds to rails within ten seconds instead of resorting to the ordinary methods of slowly heating the rail by gasoline torches or fires. This result instantly gives off a high temperature, but without injuring or decarbonizing the metal which it touches. Mr. Brown also exhibited a complete electrical testing plant with a capacity of 300 amp. for testing various types of rail bonds, fuses or electrical apparatus. This testing plant was at the disposal of any visiting engineers and was freely used.

INTERNATIONAL NICKEL COMPANY.—A beautiful and very interesting display in a large separate building is made by the International Nickel Company, illustrative of the various uses of nickel and nickel-steel, particularly with regard to nickel-steel rails and tires, of which several striking examples are to be seen. The production and use of nickel is illustrated in all its stages from the crude material through to nickel wire of the smallest gauge. The exhibit is in charge of Mr. A. L. Colby, well known as a metallurgist and as an expert in the use of nickel-steel, with whom is associated a large corps of assistants.

ADAMS & WESTLAKE.—The Adams & Westlake Company exhibits in a large pavilion its various methods of lamps and lighting of familiar type and shows elsewhere the Newbold electric axle lighting system. This is one of the latest comers in the field of electric illumination for trains and is shown in a car upon the exhibition track.

HALL SIGNAL COMPANY illustrates in its exhibit all its various types of electric motor signals and its latest improved electro-gas signal, as well as its new electro-liquid slot signal, its glass-enclosed porcelain relays and its Hall lightning arresters. The

exhibit is in charge of Messrs. A. J. Wilson, E. N. Godman and D. Boardman.

SCRANTON SCHOOLS.—The admirable work of the International Correspondence Schools, of Scranton, Pa., is illustrated in Section E of the joint exhibit building, where are shown the various text-books relating specifically to steam railroad practice and its allied branches. These books include instruction in locomotive running, electrical engineering, air braking, mechanical engineering, shop practice and courses for trainmen and carmen. The ingenious method of teaching foreign and English languages by means of the Edison phonograph is also exemplified. The schools are represented by Messrs. W. M. Mitchell, E. M. Sawyer and Louis A. Osborne.

BULLARD MACHINE TOOL COMPANY, of Bridgeport, Conn., has in Section R an admirable exemplification of its excellent work in the shape of a large vertical turret lathe driven by electric motor, and the concern is represented by Mr. S. H. Bullard. The exhibit includes also photographs of Bullard boring and turning mills for the rapid output of work, some of which is remarkable.

YALE & TOWNE COMPANY exhibits in Section C of the Combination Exhibit Building a wide variety of products, particularly its new design in electric hoists and its triplex block hoist, which, it is asserted, is able to carry the same load as the ordinary block at double the speed, but with only half the mechanical effort. The application of these hoists is illustrated by photographs of various shops. The exhibit includes also quite another range of work in the shape of builders' hardware, door checks, cabinet locks and other specialties of that character, particularly applicable to railroad cars, etc. The concern is represented by Messrs. C. W. Beaver, W. P. Bigelow and W. J. Metcalf.

YETMAN TYPEWRITER.—The Yetman Transmitting Typewriter Company, whose interesting machine has been noticed already in these pages, has an exhibit in Section B of its typewriter, and are represented by Messrs. C. E. Yetman and E. E. Cole.

WESTINGHOUSE, CHURCH, KERR & Co., while exhibiting in the Westinghouse Building, deserve separate and special mention on account of the variety and beauty of their engineering designs. As is well known, this great firm of engineers has of recent years concentrated its efforts particularly on the new field of power plants and equipments for steam railroads, as illustrated in such work as that of the Pennsylvania system, the Long Island Railroad and other systems east and west. The exhibit does justice to the modernity and excellence of their designs and plans, as well as their execution of colossal plants. The company is represented by Messrs. H. H. Kerr and A. Ranbern.

THE GENERAL ELECTRIC COMPANY has in Plot 8 a separate building whose beauty is hardly done justice to in the accompanying illustrations. It is a large building of simple and beautiful design and is not less attractive by night than by day. In fact, the night spectacle is peculiarly inviting, as the large shrubs in the vicinity are festooned with strings of the well-known Christmas tree dec-

FIG. 1.—DAY VIEW GENERAL ELECTRIC EXHIBIT.

orative lamps and outfits made by the company. A miniature fairyland is thus created in a very simple way. Within the building, which is luxuriously fitted up with office accommodations, are to be found a great many of the company's well-known devices and apparatus of sizes permitting of their display in this manner. The exhibit includes the well-known General Electric-Sprague multiple-unit train control, electric railway motors, Curtis steam turbines, automatic electric signals, combination automatic straight air brake, compressors, the mercury-arc rectifier, the combination mercury arc and incandescent lamp, and a large number of moving pictures of the General Electric locomotives, shops, etc. On a track immediately adjoining the building is shown in operation one of the latest General Electric mining locomotives with cable drum, intended particularly for coal mine haulage. The locomotive in this instance is

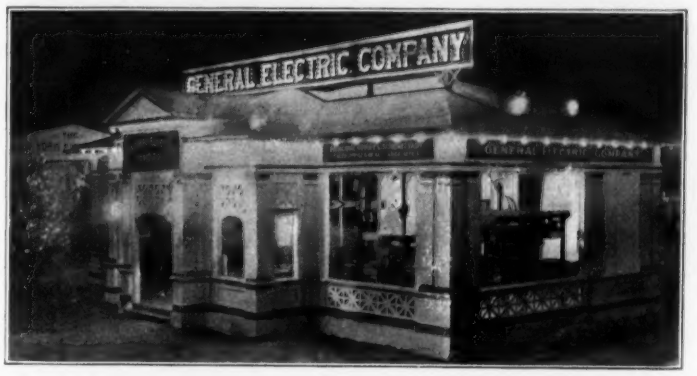


FIG. 2.—NIGHT VIEW GENERAL ELECTRIC EXHIBIT.

equipped with double cable, leaving the tracks entirely outside the circuit and thus minimizing danger and difficulty. The company has headquarters also at the New Willard Hotel and a large number of automobiles for the use of itself and friends. It is represented by Mr. W. J. Clark, who is also one of the Government delegates to the congress, by Vice-Presidents Eugene Griffin and E. W. Rice and by Messrs. J. R. Lovejoy, J. R. McKee, L. R. Pomery, W. B. Potter, A. H. Armstrong, J. G. Barry, F. H. Gale and G. W. Jones.

EDISON MANUFACTURING COMPANY have in Section P of the United Exhibit Building a display of Edison primary batteries intended for railway work, a field to which Mr. Edison has successfully addressed his energies for a great many years, his Edison-Lalande battery with low-voltage and high-amperage output, being very well known to railroad men. The company is represented by Messrs. W. S. Logue and G. A. Geyer. Mr. Bee is also present in the interest of the Edison iron-nickel storage battery.

CONSOLIDATED TRAIN LIGHTING.—The Consolidated Railway, Electric Lighting & Equipment Company has in Section O of the Combination Exhibit Building a standard truck illustrative of its axle system of train lighting, it being equipped with a generator as well as with switchboards and regulators typical of the excellent work done by this company, which has now something like a thousand cars to its credit in this country as the result of its pioneer and incessant work in this field. The company is represented by Col. John P. Dickenson and by Messrs. P. Kennedy, Thomas Mount, G. Dorman and W. M. Lalor.

CROCKER-WHEELER COMPANY, of Ampere, N. J., has not made any special exhibit within the space reserved for the show, but has an excellent display at the Washington Monument immediately adjoining, where its equipment is employed for operating the big elevator. During the two weeks the delegates have also been given frequent opportunities to see Crocker-Wheeler motors in operation, particularly in the Government Printing Office, where several hundreds are at work on every kind of operation, and at the Navy Yard, where some extremely heavy tools are driven by C-W motors.

ELECTRIC STORAGE BATTERY COMPANY has a handsome separate building occupying Plot 4 and there makes a large and complete display of its Chloride accumulators as employed in all classes of steam railway and electric railway work, ranging from train car lighting up to the huge batteries employed in sub-stations and for supplying current direct to large plants. The work of the company is illustrated and exemplified in all its details and the display is most significant and convincing, not only as to the part already played by the storage battery in the traction field, but as to the share that awaits it under all the varying changes through which the art is still passing. The company has a large staff on the grounds and its building is a center of attraction by night and by day.

GOULD STORAGE BATTERY COMPANY has, with the Gould Coupler Company, in a special building occupying Plot 8, an excellent illustration of its storage battery and of its electric car lighting system now familiar to all our readers. The building includes also the wide range of railway specialties and devices with which the well-known name of Gould is so intimately connected. The com-

pany is represented by Messrs. F. P. Huntley, W. R. Turbayne, T. L. McKean and M. H. Shedd. The Gould lighting system is naturally well known to steam railroad men from its use on the New York Central's lines and other main roads.

ELECTRICAL WORLD AND ENGINEER and other McGraw publications were represented throughout the congress and exhibition by a large staff, including President J. H. McGraw and Messrs. J. M. Wakeman, H. W. Blake, T. C. Martin, H. Buttenheim and C. A. Babtiste and Dr. N. M. Hopkins, of the Washington staff.

THE LUNKENHEIMER COMPANY, of Cincinnati, has a fine display in Section G of the exhibit building of its well-known railroad and locomotive specialties, including its Globe angle and cross regrinding valves, Lunkenheimer locomotive blow-off cocks, Duro blow-off valves and a wide range of brass fittings.

OTTO GAS ENGINE WORKS have a separate building in Plot 4, where they make an excellent display of their gas engines in conjunction with dynamos, pumping machinery, air compressors, Winters' automatic signal batteries, Otto water crane, Moore track jack, as well as tank valves, track wrenches, etc. This interesting and composite display makes an appeal to a wide variety of steam railroad and electrical men and the building has been constantly filled with visitors from all parts of the world. The company is represented by Messrs. T. W. Snow, E. L. Winters and C. C. Lazenbey.

SPRAGUE ELECTRIC COMPANY has, in conjunction with the General Electric Company, in Plot 8, an exhibit of the Sprague electric drilling hoist, as well as of its flexible armored steel hose for steam or compressed air work. The concern is represented by Messrs. A. C. Bakewell, E. H. Watlington and G. C. Conner.

FREE TELEPHONE SERVICE over the long-distance lines was generously furnished by the American Telephone & Telegraph Company daily between the hours of 5 p.m. and 9 p.m. This privilege was highly appreciated by the delegates. Mr. Frank Bethell, manager of the Chesapeake & Potomac Telephone Company, stated that the presence of the congress in Washington had greatly increased the work of the local Bell telephone system.

HERMAN SIGNAL SYSTEM.—Electrical and railway engineers were very much interested to note that the General Electric Company has gone into the signal field, having acquired all the patents, rights and tools of Mr. R. Herman relative to his automatic, electrically-operated block signals, and other devices. The Herman signal, which will now be known as the General Electric signal, has shown on test 74,100 consecutive complete movements of the signal, driven by a standard primary battery which was given no attention during the test. This signal possesses important advantages in the simplicity and substantial construction of the mechanism, which is placed in the top post mechanism case, measuring 14 in. x 17¾ in. x 12 in., and so disposed as to render each part easy of access and open to inspection through doors which provide protection in all weather. The few moving parts and the lack of complication reduce the cost of maintenance and at the same time insure the certain operation of the signal. The General Electric Company also supplies bottom post mechanisms of the same design when desired.

The Westinghouse Exhibit at the International Railway Congress.

Last week a preliminary illustrated notice was given of the remarkable Westinghouse exhibit at the International Railway Congress in Washington. Occupied as is the handsome booth by nearly two score Westinghouse companies, in all parts of the world, the display constitutes in itself a very complete exhibition of the modern industrial arts, and is to be commended as much for its technical value as for its commercial appeal. As mentioned last week, in regard to the more specific electrical features, the exhibit includes all forms of Westinghouse multiple unit control and of motors, as well as a 600-hp steam turbine unit, and the lighting includes Nernst and Cooper Hewitt lamps, while the roof of the building has brilliant electric signs.

The Westinghouse magnetic brake is shown in operation by an arrangement of a moving track; the Westinghouse friction draft gear is displayed on a testing rack on which it is compressed with an air force of approximately 150,000 pounds, a slow and serial release without recoil demonstrating a feature of prime importance in its operation; and the locomotive driver brakes and the automatic slack adjusters of the American Brake Company, racks hung with valves of various forms shown in sections, and several types of motor-driven and steam air compressors complete the display. The operation of Westinghouse air brakes is completely illustrated in the "instruction car" of the Brake Company on the special track at B and Fourteenth Streets, in charge of the company's regular instruction corps.

The most important feature of the electric traction exhibit is a 50-ft. dummy car platform completely equipped with Westinghouse

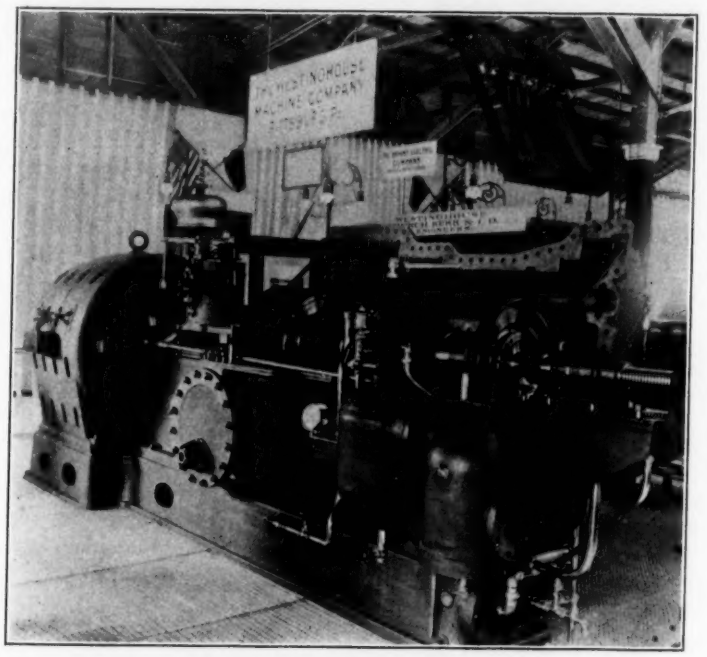


FIG. 1.—WESTINGHOUSE TURBO-GENERATOR EXHIBIT.

single-phase motors and "straight-air" brakes, and with the Westinghouse unit system of multiple control as designed for alternating-current practice, with induction regulators by means of which a variable operating voltage is secured to provide a wide range of speed without resistance losses. The motors are of type No. 106, 100-hp capacity, two on each truck; and the master controller and brake operating valve are mounted at each end of the platform as in the motorman's cab, the entire car frame being so raised above

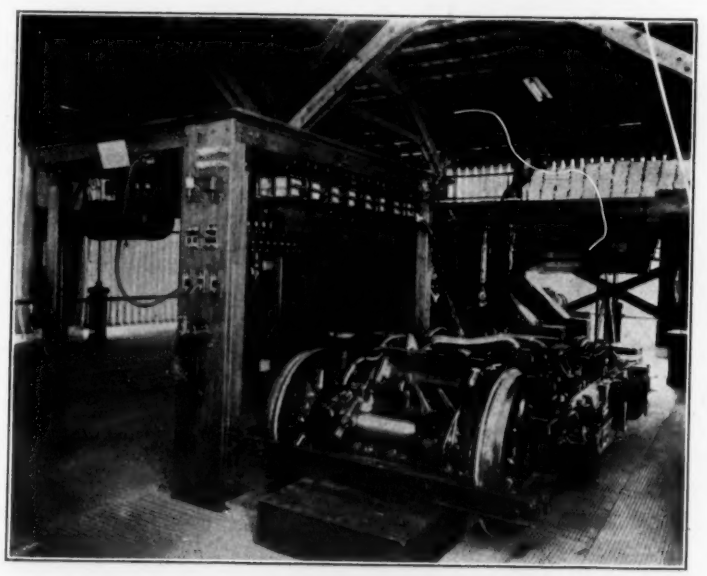


FIG. 2.—WESTINGHOUSE MOTOR EQUIPMENT FOR LONG ISLAND RAILROAD.

elevated tracks as to permit the revolution of the wheels under slight frictional pressure on greased rails to keep the motors under load. The tracks are raised several feet above the floor to permit thorough inspection of the under hanging parts, and a side platform reached by a stairway affords a close view of the motor mounts. The entire equipment is similar to that of the Westinghouse single-phase cars built for the Vallejo, Benicia & Napa Valley road in California, the Blairsville & Derry line, near Pittsburg, and other

alternating-current suburban systems not requiring combination rheostatic control for direct-current service over tracks within city limits previously equipped. The straight alternating-current system is exhibited as more desirable than the combination equipment, as its advantages of a simpler and more efficient method of control are particularly important in the frequent starts and stops of city service.

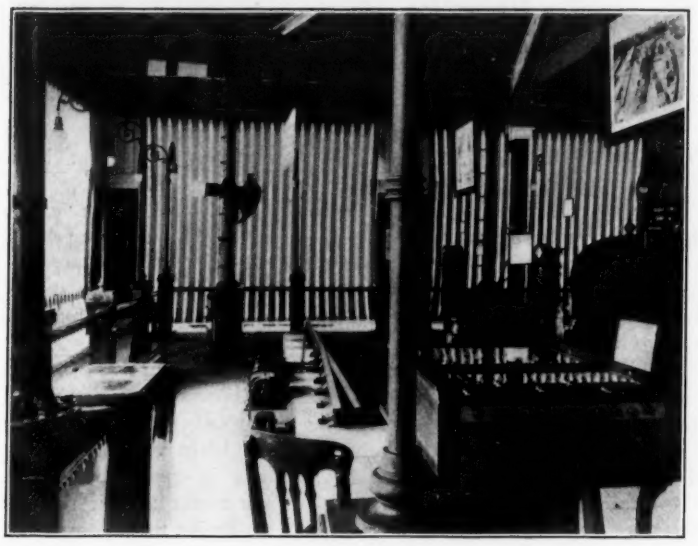


FIG. 3.—SWITCH AND SIGNAL EXHIBIT.

Alternating current for the operation of the motors is obtained from a 400-kw rotary converter, running inverted, which receives direct current at 500 volts from outside the exhibition grounds.

The latest form of Westinghouse multiple control for direct-current practice is demonstrated in the complete car equipment for the operation of a truck driven by two No. 113 motors, each of 200 hp capacity, a type embodying slight modifications of motor No. 86 for heavy train service on the Long Island Railroad. The unit switch group is enclosed in a rectangular casing more substantial than the turret box, every switch is a circuit-breaker, and provision is made for changing from series to multiple operation of the motors without opening circuits, by a bridging system, which is effectively demonstrated in the operation of the exhibit truck.

The motor-driven tools on exhibit are all equipped with type S shunt-wound motors, for constant-speed or variable-speed service, and for operation on direct-current circuits at 220 volts. The prominent feature of this display is a giant locomotive driving wheel lathe weighing over 100,000 pounds, built at the Ohio works of the Niles-Bement-Pond Company, equipped with a 40-hp motor mounted

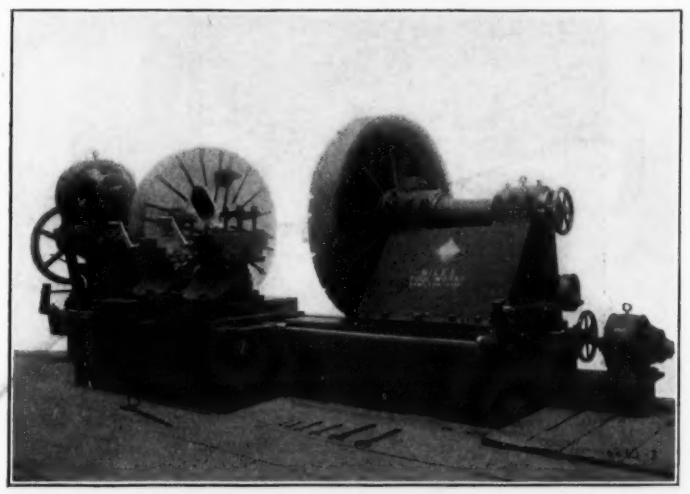


FIG. 4.—MOTOR-DRIVEN WHEEL LATHE.

at the top and direct-geared to the revolving and feed mechanism, and with a 5-hp motor of 1,050 r.p.m., for traversing the movable head. The large motor has a speed variation of from 490 to 980 r.p.m., and gear changes provide a total range of cutting speeds of from 10 to 25 ft. a minute on all diameters of wheels from 48 to 90 in. The face plates of the lathe are mortised to receive the crank pins, thus permitting the "chucking" of the wheels close to the plates, the absolutely rigid hold on the tires under the heaviest cuts greatly facilitating the operation of the machine, which has a capacity of truing six pairs of driving wheel tires in a ten-hour day. The great weight and strength of this machine and the high capacity of the motor applied to it are an interesting example of the improvements in heavy shop machines brought about in the past few years by the advent of new tool steels. Another Niles machine on exhibition is a double-axle lathe, driven by a 20-hp motor of from

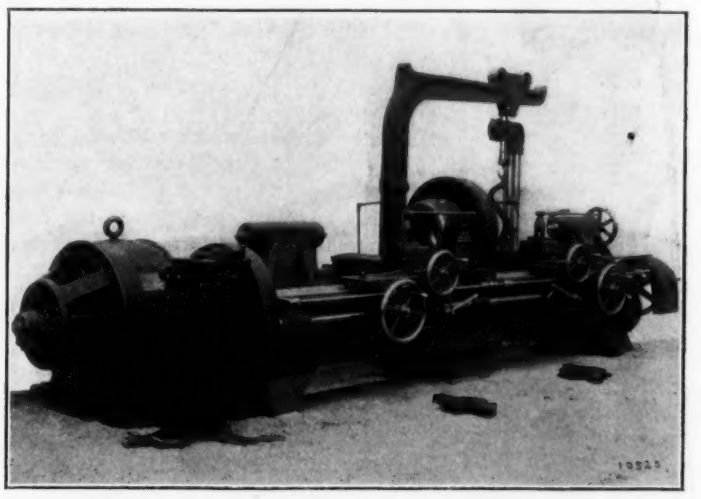


FIG. 5.—MOTOR-DRIVEN AXLE LATHE.

340 to 1,200 r.p.m., mounted on an extension to the bedplate and gear-connected to the mechanism, the machine having a total cutting diameter of 12½ in., capable of turning the largest axles, and being built with two carriages, so that both axle ends are turned simultaneously. Other tools on exhibit are a Putnam' roughing lathe, driven by a 50-hp motor of from 500 to 1,000 r.p.m.; and a Sellers universal tool grinder, driven by a 7½-hp motor of 975 r.p.m., mounted on a bedplate extension and belt-connected to the driving shaft.

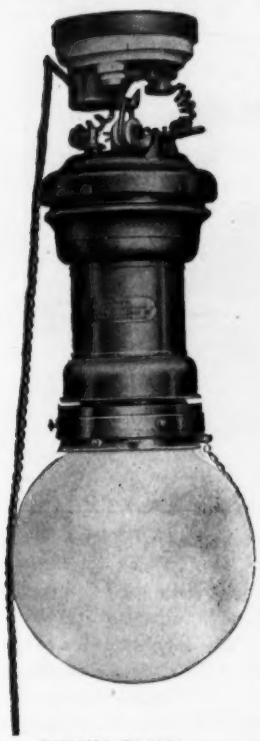
Annual Meeting of the Technical Publicity Association.

An interesting address on "The Machinery for Marketing Machinery" was presented at the annual dinner of the Technical Publicity Association in New York, April 27, by Emerson P. Harris, a specialist in trade and technical journalism. This organization already represents over 30 large manufacturers and many concerns engaged in allied branches of industry are now turning their attention to the problem of "printed salesmanship." The members of the association, nearly all of whom were in attendance at the dinner, are Philip P. Kobbe, Rand Drill Company, president; H. M. Cleaver, Niles-Bement-Pond Company, vice-president; C. B. Morse, Ingersoll-Sergeant Drill Company, second vice-president; George H. Gibson, International Steam Pump Company, secretary; H. M. Davis, Sprague Electric Company, treasurer; Rodman Gilder, Crocker-Wheeler Company, and Graham Smith, Westinghouse Companies, executive committee; H. T. Lauretzen, Holophane Glass Company; F. S. Wayne, Robins Conveying Belt Company; Lucius I. Wightman and Fred C. Iglehart, Ingersoll-Sergeant Drill Company; J. C. McQuiston and J. O. Little, Westinghouse Companies; C. P. Hutchins, Joseph Dixon Crucible Company; F. C. Cheston, American Wood Working Machinery Company; Dean Park, Hammacher, Schlemmer & Co.; F. R. Matthews, De La Vergne Machine Company; Dixon Boardman, Hall Signal Company; F. H. Gale, General Electric Company; C. S. Redfield and R. R. Glenn, Yale & Towne Manufacturing Company; A. E. Michel, International Steam Pump Company; A. N. Barber, John A. Roebling's Sons Company; W. B. Snow, B. F. Sturtevant Company; E. P. Schaefer, Rand Drill Company; H. H. Kress, Cameron Steam Pump Works; F. B. Vail, American Air Compressor Works; Arthur Warren, Allis-Chalmers Company; A. E. Newton, I. T. E. Company.

The address of Mr. Harris dealt in a practical but philosophical way with the development of the modern technical journal, and emphasized the tendency toward the "intensive" concentration of advertising effort in each field in a few typical leading journals.

New Ceiling Board.

One of the features of an improved porcelain ceiling board for arc lamps, which the General Electric Company has just placed on the market, is the use of a snap switch and a ratchet and chain, the lamp and board thus being self-contained and requiring no additional wiring to connect them with a switch. Every lamp in a circuit is made independent of the other lamps by means of standard Edison plug cut-outs, which afford a better means of protection than does the general cut-out. The ceiling board is furnished for either concealed or cleat wiring.



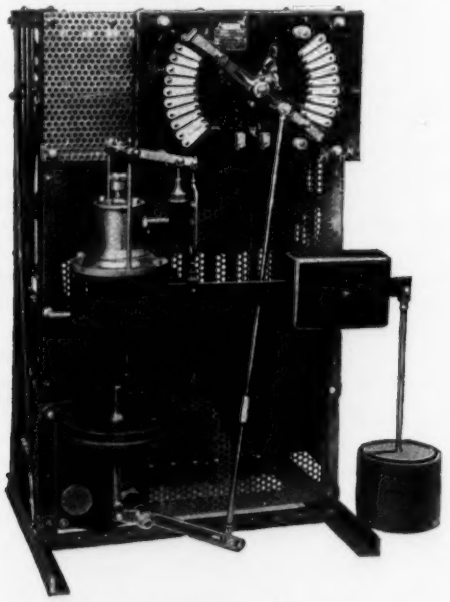
CEILING BOARD.

The hook from which the lamp hangs is supported by a spiral spring mounted in a recess in the porcelain. This spring takes up any jarring to which the lamp may be subjected, reducing the vibration to a minimum. This ceiling board is, therefore, particularly adapted for use with lamps installed on wharves, and in railway stations, factories and mills. The illustration shows the ceiling board supporting an alternating-current multiple arc lamp.

Automatic Speed Adjuster.

The Cutler-Hammer Manufacturing Company, Milwaukee, has developed an automatic speed adjuster to meet some special requirements of motor control, particularly in connection with mechanical stokers for induced draft, forced draft systems in boiler plants, and in pumping plants, where it is desired that the motor operate continuously and supply water continuously at certain pressures, the volume of water furnished varying with the demand.

For boiler draft fans the regulator proper, shown in the cut as mounted at the lower left-hand corner of the resistance frame, con-



AUTOMATIC SPEED ADJUSTER.

sists of a regulator controlled directly by the steam pressure, acting upon a hydraulic cylinder whose piston in turn is mechanically connected to the rheostat lever. The steam pressure is admitted directly below the diaphragm of the pressure regulator and is balanced by the weights on the lever. The lever will, therefore, rise and fall slightly with the rise and fall of steam pressure in the boilers.

The operation of the hydraulic cylinder is controlled by a pilot valve, which in turn is controlled by a floating lever between the crosshead on the hydraulic cylinder piston rod and the link from the regulator lever. The piston will be forced downward when the regulator lever rises, and the relative motion of its rod and the link from the regulator weight lever operates the pilot valve. When the pressure rises, slightly opening the pilot valve, water is admitted to the hydraulic cylinder, forcing its piston downward and thereby causing the pilot valve to move a corresponding amount. Any slight rise or fall of the pressure causes a corresponding fall and rise of the hydraulic cylinder and a corresponding operation of the rheostat lever. The parts are so proportioned that with a certain variation in pressure the rheostat lever will travel from one end of its contact to the other, and for smaller variations a proportional smaller travel will be obtained. As the pressure rises, the motor is slowed down, decreasing the draft, and conversely, if the pressure falls, the motor is accelerated, increasing the draft. The pressure may thus under all demands on the boiler be automatically kept within the limit of two pounds above or below a given normal pressure.

The speed of the motor may be controlled by resistance in the armature circuit, by resistance in the shunt field circuit or by a combination of these two. For very large motors, speed control is obtained by means of solenoid switches, and the rheostat lever shown on the drawing is, therefore, used only to control the windings of the several solenoid switches.

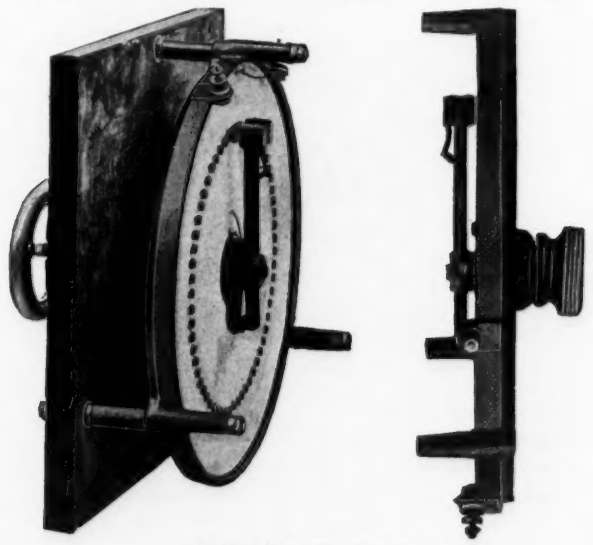
In the case of pumping plants, where a small amount of water is being used, and it is desired that the motor be run at a slow speed, and as the demand increases by opening up more outlets, it is necessary that the motor speed be increased to maintain a constant pressure at the source of demand. The regulator in connection with a motor-driven pump, adjusts the speed of the motor to suit the demand upon the system automatically, and maintains the motor speed constant at a given point as long as the demand remains constant.

For small equipments it is usual to install in connection with the regulator a standard automatic-release type of starter. An automatic starter is also advisable for starting the motor up after having been shut down.

Enameled Rheostats.

The Ward Leonard Electric Company, of Bronxville, N. Y., has standardized several new and important features in its enameled field rheostats. Formerly the starting contacts were made of two pieces—the outer one showing above the enamel being "sweated" into the supporting piece under the enamel. These "two-piece" buttons have been abandoned, and have been replaced by "one-piece" buttons.

Formerly the movable sliding contact was a phosphor bronze blade. This has been replaced by a self-aligning, renewable, copper skate



ENAMELED RHEOSTAT.

shoe, the contact being entirely independent of the pressure of the operator upon the controlling handle.

The cut shows clearly the shoe contact and also the flexible stranded lead wire which carries the current from the contact-shoe to the centre stud.

The new type embodies an improved method of changing rheostats from the front to the back of boards. This change can be made in ten seconds. It is only necessary to unloosen one screw, and rearrange the shaft which carries the hand wheel. The hand wheel is solid, and does not cut the hand when being used.

Simplex Instruments.

It has been the practice to support the moving system of measuring instruments of the permanent-magnet, moving-coil type, when applied to switchboard and similar work, upon hardened-steel pivots in jeweled bearings, and to conduct the current into and out of the moving coil by means of spiral springs. Such construction is, however, open to several objections, as follows:

1. Changes of temperature are liable to condense the moisture of the air enclosed in the instrument case, upon the steel pivots, causing

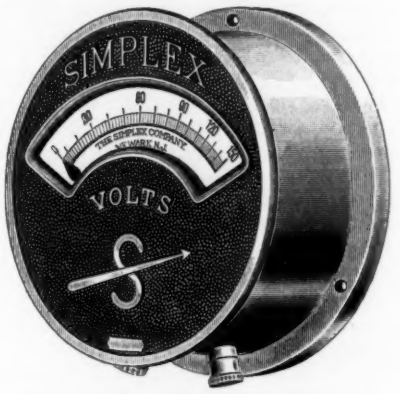


FIG. 1.—SWITCHBOARD INSTRUMENT.

them to rust, destroying their fine needle points and smooth surfaces, and thereby creating friction in the bearings with the result that the proper operation of the instrument is interfered with.

2. The fragile nature of both the bearing points and the jewels renders them liable to fracture under sudden jar or long-continued vibration.

3. Some play or movement in the direction of the axis of the pivots must be allowed for, to prevent binding in the jewels, and

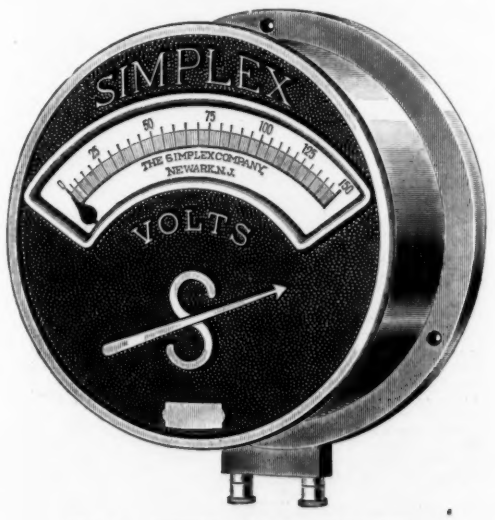


FIG. 2.—SWITCHBOARD INSTRUMENT.

where the magnetic gap clearances are small, as is usual in practice, the side thrust of the moving system frequently binds the latter against the adjacent pole-pieces.

To remedy these defects, the Simplex Company, of 60 Nassau St., Newark, N. J., have brought out a permanent magnet suspension instrument which is entirely free from the objections cited. Figs. 1 and 2 illustrate the common switchboard form of this type. The general internal mechanism is shown in Figs. 3 and 4, of which the former is a top view looking down on the instrument scale (the case and cover being removed), and the latter is a section somewhat enlarged on *AB* of Fig. 3.

By referring to these figures it will be noted that the instrument involves a horse-shoe permanent magnet having four flat soft-iron pole-pieces and a flat disc soft-iron core. The moving system consists of a flat rectangular coil wound on a damping frame, supported above and below by straight band conducting filaments which are attached through a yielding support to insulated bridge pieces. The pole-pieces, core, bridge pieces and scale are all supported by a one-piece structure rendering their mutual alignment permanent. The pole-pieces fit tightly into recessed slots in the magnet ends, and

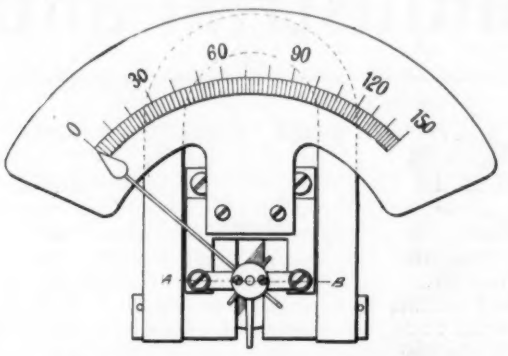


FIG. 3.—DIAGRAMMATIC VIEW OF SCALE.

perfect magnetic contact results. The magnet is secured in place by cotter pins tightly driven into the pole-pieces.

The filaments, which serve the triple purpose of supports, electrical conductors and retarding springs, are made from a highly resilient bronze alloy of good conductivity, low temperature coefficient and high tensile strength. They are non-oxidizable and so proportioned that they radiate easily the heat generated in them at maximum reading.

The yielding support mentioned above is an important feature of the device, as it protects the moving system from damage by jar or

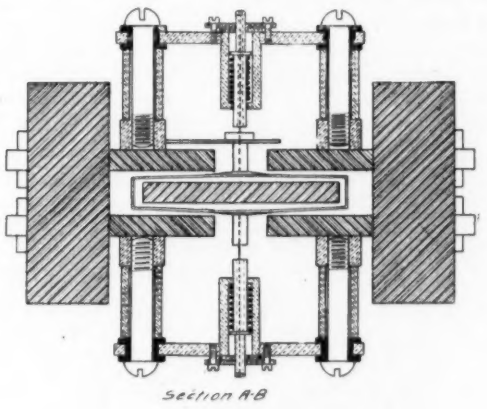


FIG. 4.—SECTION AND PLAN VIEWS.

continued vibration, and corrects for the change in the length of the filament due to change in temperature or angular movement of the moving coil.

The pull upon the filament is so regulated that the latter is kept perfectly taut, and the moving system being balanced, the insrument may be operated in any position. The flat moving coil with its particular arrangement of magnetic air gaps, has its entire coil surface active, thus allowing a lighter coil than would otherwise be necessary.

The magnet is assembled with its pole-pieces and core before ageing, and the latter are not again removed, the front arrangement of the parts being such that the moving coil may be readily assembled or removed without disturbing any of the other parts. The magnet is made up of a high grade of Swedish magnet steel notable for its strength and permanence, and is thoroughly treated and aged by special processes.

In operation the instrument behaves exactly like a pivot and jewel-supported moving coil instrument, except that there is an entire absence of friction. It may be subjected to unusually severe jars or vibration without damage and will operate perfectly under all atmospheric conditions.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.—On the whole, trade reports were encouraging, although the unsettled weather checked business somewhat, and industrial activity is unabated. Textile manufacturing is in a better condition that at any recent date, the strength of the raw materials giving additional firmness to finished fabrics. Heavy rains or cool weather have retarded corn and cotton crop preparations and retail trade, but have rather favored winter wheat, which fully holds the magnificent promise of a month ago, while an increased area is certain in spring wheat, which latter, however, needs more moisture. Iron and steel are rather quieter as regards new business, and increased ease is noted in old material, pig iron and bars, but structural material is eagerly bid for, and large orders for railway cars guarantee activity for the mills for months to come. The building trades and allied lines, such as lumber, hardware, paints and glass, are apparently doing the business of their lives, unchecked and untouched by the usual May-Day labor disturbances. Traffic returns are well maintained, railway earnings for April exceeding last year's by 10.5 per cent., and lake navigation is heavy. All statistical measures of trade progress point to general business showing satisfactory increases over preceding years at this date. Bank clearings are of enormous volume—next to the largest ever recorded—failures are fewer and liabilities smaller than a year ago, railway earnings are indicative of a heavy tonnage movement, but money remains strikingly easy, considering present and recently past activity in trade and finance. The copper market made a further decline in prices, all grades being affected. Lake and electrolytic are held at 15c. and casting stock at 14¾c. Business was dull, but there were indications of an improvement, the exports keeping up in good volume. The business failures for the week ended May 4, according to *Bradstreet's*, numbered 193, same number as those of the week previous, and 176 in the corresponding week last year. In the month of April there were 763 failures, aggregating $8,745,596, a decrease in number of 4.6 per cent. and in liabilities of 36 per cent. For four months there were 3,704 failures, of an aggregate of $37,797,905 in liabilities, an increase of 1 per cent. in number, but a decrease of 38 per cent. in liabilities from 1904.

PROTECTIVE APPARATUS.—Frank B. Cook, Chicago, has received from the Stromberg-Carlson Telephone Manufacturing Company, an order for the equipment of protective apparatus for the new Dixon, Ill., exchange which has just been installed. Mr. Cook in the last month has received orders for over 20,000 pairs of his No. 8 self-soldering protectors, among the largest of these orders being the Twin City Telephone Company, St. Paul, Minn., 700 pairs; Southern Indiana Telephone Company, El Paso, Tex., 1,500 pairs; Sioux City Telephone Company, Sioux City, Ia., 2,000 pairs; Kittanning Telephone Company, Kittanning, Pa., 600 pairs; Princeton Telephone Company, Princeton, Ind., 600 pairs; Twin City Telephone Company, Minneapolis, Minn., 1,300 pairs; Illinois Telephone Company, Carrollton, Ill., 400 pairs; Hagerstown Telephone Company, Hagerstown, Md., 300 pairs. Mr. Cook also has received a great many orders for his pole cable terminals, one of the largest being from Jones & Winters, for the new exchange at Green Bay, Wis. This order is for 111 terminals, part of them being Cook's new M 2-pole top terminals, and the others the type S. M pole cable terminals with mica fuses, for use without potheads.

THE AUTOMATIC ELECTRIC COMPANY of Chicago closed four contracts for new automatic telephone plants during the month of March, besides several contracts for additional equipment for exchanges already built. The latest contract is for a complete system of 1,500 lines for the Southern Independent Telephone Company, of El Paso, Tex. The complete central office equipment will have an immediate capacity of 1,500 lines and an ultimate capacity of 10,000 lines. The Automatic Electric Company is now building or installing public exchanges for Los Angeles, Cal. (3,000 lines in addition to the 6,700-line automatic exchange already completed, making 9,700 lines in all); San Diego, Cal.; Columbus, Ohio (8,000 lines); Sioux City, Ia.; Hastings, Neb.; South Bend, Ind.; Wausau, Wis., and El Paso, Tex., and private exchanges for the Milwaukee Electric Railway & Light Company, Milwaukee, Wis.; the York Manufacturing Company, Saco, Me.; Frankford Arsenal (Ordnance Department, U. S. A.), Bridesburg, Pa., and Springfield Arsenal (Ordnance Department, U. S. A.), Springfield, Mass. These last will make five automatic telephone exchanges that the United States Government has purchased.

APPARATUS FOR WISCONSIN.—The Wisconsin Light & Power Company, of La Crosse, Wis., has placed orders with the Westinghouse Companies covering the entire equipment of a large light and power plant. Besides two alternating-current generators with an output of 400 kw each, which will be driven by Westinghouse-Parsons steam turbines, there are three Westinghouse vertical steam engines, one of which will be connected to a 25-kw, direct-current generator. The order also includes two motor-generator sets, each consisting of a 7½-kw direct-current generator and a 15-hp type C induction motor; three 10-kw and three 15-kw O. D. transformers; one 6,600-volt, ten-panel switchboard and one 220-volt arc lamp panel; fifteen low equivalent lightning arresters and choke coils; 25,000 incandescent lamps with Edison base. Roney stokers manufactured by the Westinghouse Machine Company will be used in the boiler installation.

AUTOMOBILE ELECTRIC HORN.—It is noted that a novel electric horn, the invention of an ingenious Frenchman, is being put on the market by Charles E. Miller, the well-known dealer in automobile supplies, in New York City. It seems likely not only to cause somewhat of a sensation, but to become popular as well. A vibrating coil is connected with the battery of the car. A button is placed on the steering wheel or any other place convenient to the driver. The pressure of the button is imparted through a wire to the diaphragm of the vibrating coil and regulates the continuation and the loudness of the horn's signal sound. Mr. Miller at present is but selling agent for the horns. He is, however, negotiating for the American rights, so as to manufacture them in this country himself.

THE INDIA MICA COMPANY, which was recently incorporated under the laws of Massachusetts for $50,000, owns a property near Canaan, N. H. The vein is ten feet wide and contains much "ruby" mica. The company does not cut or manufacture mica, but mines it in the rough. Its mine was worked twenty years ago by another company (now out of existence). At that time only large sheets were used and there being little development in electricity, small sizes were cast aside. The machinery for mining purposes has been installed and the company has already begun to ship. The company has no outstanding bonds or debts, the stock is controlled by a few individuals and none is offered for sale as they believe the property will be very valuable. The head office is at Lawrence, Mass. The officers are: President, W. K. Moorehead, Andover, Mass.; treasurer, A. Adler, Lawrence, Mass.

BELL TELEPHONE OUTPUT.—The American Telephone & Telegraph Company's instrument statement for the month ended March 31 and since December 31 compares as follows:

	1905.	1904.	1903.	1902.
Gross output	169,169	126,522	84,280	96,557
Returned	47,645	35,043	38,172	42,847
Net output	121,514	91,479	46,108	53,710
Since Dec. 31:				
Gross output	434,094	301,568	305,961	279,553
Returned	132,922	108,990	116,646	114,498
Net output	301,172	192,578	189,315	165,055
Total outstanding	4,781,736	3,972,095	3,339,635	2,691,065

THE INTERNATIONAL TELEPHONE MANUFACTURING COMPANY, Chicago, reports the following recent sales of its mechanical self-restoring drop switchboards and central office equipment: Winona Telephone Company, Winamac, Ind., five switchboards and auxiliary equipment for its various exchanges; Delta County Cöoperative Telephone Company, Paonia, Col., three complete central office equipments; Ida Telephone Company, Ida, Mich., two exchange equipments; Henry, Ill., Colchester, Ill., La Prairie, Ill., Ligonier, Ind., Oak Grove, Mo., Malta Bend, Mo., Pleasantville, Ia., Exira, Ia., Manson, Ia., Gilman, Ia., Vinton, Ia., Judyville, Ind., Sanford, Ill., and Minier, Ill.

CANADIAN BIDS.—J. H. Hargreaves, commissioner of public works, Edmonton, Alberta, N. W. T., will receive bids until May 15 for wire, transformers, switchboard and all the necessary material for the installation of series arc lighting.

SCHOOL EQUIPMENT.—Bids will be received May 15 by C. B. J. Snyder, superintendent school buildings, New York City, for installing electrical equipment in School No. 85, Borough of Manhattan.

BIDS FOR FIXTURES.—Abe S. Bickham, quartermaster, Fort Hancock, N. J., will receive bids until May 20 for installing electric lighting fixtures in five buildings at Fort Hancock.

BANNER ELECTRIC WORKS.—The Youngstown, O., *Telegram* says: "The Banner Electric has not only decided to keep its factory in this city, but has purchased ground on the South Side and will move its plant from South Champion Street to the new site as soon as a building is ready. The building will be 40 feet wide by 200 feet deep, three stories and basement and will be large enough to allow for future extension of the business. The material will be tile or brick. The estimated cost is $8,000. It was stated by Manager N. L. Norris that the company has refused two offers to move the plant away from Youngstown. He showed a letter which was received from another city offering a deed for a $10,000 property if the company would take its plant there. Mr. Norris said the propositions to move had been given careful consideration, but that the one argument which finally decided it on remaining in this city was that the employes are all experienced and their homes are in this city. The shipping facilities here are satisfactory so that it was concluded that the company would probably do as well if not better to continue in Youngstown than to move away. The Banner Electric Company began the manufacture of incandescent electric lamps in November, 1881. Their business has grown steadily ever since and the volume for the past year showed a big increase over the year previous which was better than any of its predecessors. The company now has branch offices with signed stock in many large cities, including Savannah, New York, Pittsburg, Cincinnati, Chicago, St. Louis, Saginaw and San Francisco. The directors are President J. Evans Lippincott, owner of the Lippincott glass works at Alexandria, Ind.; vice-president, Thomas Carr, of this city; treasurer, O. U. Cassidy; secretary and general manager, N. L. Norris; superintendent, F. C. Kirchner, Clarence S. Crook and R. T. Hamilton."

NATIONAL CARBON.—A Fremont newspaper says: "J. W. Dietrick, superintendent for the Hunkin Bros. Construction Company, general contractors and builders, Cleveland, arrived in Fremont recently and at once made arrangements to begin the work on the new addition to be erected at the plant of the National Carbon Company, on West State Street. The plans for the new buildings were prepared by the Osborne Engineering Company, of Cleveland, and several of the engineers for this concern also reached Fremont later on to look after the preliminary work. The new building is to be a three-story brick and its erection is to be pushed to a speedy completion. The officials of the Carbon Company are not giving out much information concerning their plans and what they propose doing at the Fremont plant, but it is evident that they are going to do things or they would not be enlarging and erecting new buildings. The National Carbon Company is just now turning out dry batteries, searchlights and other electrical appliances which are to be made here."

ALLIS-CHALMERS ORDERS.—The Allis-Chalmers Company has received orders from the Tuolumne Electric Company, of San Jose, Cal., for a 600-kw Bullock alternator, two 35 kw exciters and three 220-kw transformers, for its hydroelectric power plant now nearing completion. The H. C. Frick Coke Company has ordered for installation at one of its mines near Connellsville, Pa., three 400-kw Bullock alternators, three 200 kw rotary converters, nine oil-cooled 75 kw transformers, a 50-kw excitation generator direct coupled to a 75-hp induction motor, and a complete switchboard installation for the plant. The Hamilton Gas & Electric Company, of Cincinnati, which is remodeling its plant, has ordered two 250-kw Bullock alternators with exciters, and a 150-hp induction motor direct-connected to a 100-kw direct current generator. The United States Coal & Coke Company, of Pittsburg, has ordered a Reynolds-Corliss engine to be direct connected to a 750-kw alternator.

WELLMAN-SEAVER-MORGAN AGENCIES.—Mr. A. P. Head, the London representative of the Wellman-Seaver-Morgan Company, has just completed a tour around the world and has established the following sub-agencies for the Wellman-Seaver-Morgan Company: Melbourne, Australian Metal Company, as Australasian agents. The branches of this concern are as follows: New Zealand, the Gilbert Machinery Company, Wellington; Queensland, James Stothert, Brisbane; N. Queensland, James Croker, Mackay; New So. Wales, W. R. Laidley, Sydney; So. Australia, James C. Fraser, Adelaide; W. Australia, A. E. Thomas, Koolgardie; Tasmania, Lindsay Tullock, Launceston. In India the following agents representing the presidencies of Bombay, Bengal and Madras, have been appointed: J. Harper, Calcutta; Frank Harrison, Bombay, and W. H. Oakes, Madras.

MOTORS IN A TANNERY.—A very interesting application of electric motors will be made in the Anchor tannery, of Cincinnati, which was recently destroyed by fire, and which is now being rebuilt by Rudolph Suhre Sons, the proprietors. The engineering details of the work have been in the hands of Maphet & Dressel, consulting engineers, of Cincinnati. The machinery throughout the tanning process will be operated individually by electric motors, the aggregate capacity of which will be 100 hp. The contract for the generator was recently placed with the Bullock Electric Company, and the motors are to be furnished by the Crocker-Wheeler Company.

TELEPHONY IN OKLAHOMA.—A special meeting of the stockholders of the Missouri & Kansas Telephone Company will be held in Kansas City, May 17. 1905, to change the by-laws to permit of a board of directors of eleven instead of nine members. The question of selling all the property and franchises of the company in Oklahoma and the Indian Territory will also be decided. The management is in favor of disposing of the company's interests in both Oklahoma and the Indian Territory as the service is expensive to operate and its developments will entail further large expenditures.

NAVY BIDS.—Bids will be received May 31 by the Bureau of Supplies and Accounts, Navy Department, Washington, for furnishing at the navy yards at Portsmouth, N. H.; Boston, Mass.; Newport, R. I.; New York, N. Y.; League Island, Pa.; Washington, D. C., and Norfolk, Va., electrical wire, battery cells, motor, etc. Also May 23 for furnishing at the Navy Yard, Pensacola, Fla., and naval stations, Key West, Fla.; New Orleans, La., and San Juan, P. R., supplies for batteries, etc. H. T. B. Harris, paymaster-general, U. S. N.

ALLIS-CHALMERS RAILWAY EQUIPMENTS.—The Cincinnati, Milford & Loveland Traction Company has placed an order with the Allis-Chalmers Company for five complete car equipments, each consisting of four 50 hp, 500-volt Bullock motors, together with other auxiliary apparatus. The Cleveland, O., Electric Railway Company has ordered a Reynolds-Corliss condensing engine for direct connection to a 1,500-kw street railway generator, this being the fourth engine of this type supplied to the same company.

MAGNETITE ARC LAMPS.—During the past year a number of central stations have closed contracts with their respective cities on the basis of magnetite arc lamps for public lighting. Among these are Jackson, Mich., capacity, 300 lights, operating for a year; Marysville, O., capacity, 70 lights, operating since last summer; Williamsport, Pa., 300 lights, operating since February; Harrisburg, Pa., 800 lights, operating since March, and St. Joseph, Mo., 550 lights, now being stalled.

SUPPLY DEALERS' MEETINGS.—Meetings have been held at the Imperial Hotel, New York City, during the past week, of the Atlantic division of the Supply Dealers' Association. Meetings have also been held of the executive committee of the National Association of Supply Dealers and the executive committee of the National Electrical Contractors' Association. As usual, the proceedings were held behind closed doors, and nothing of interest was given out.

G. M. GEST, the subway contractor of New York and Cincinnati, has been awarded the contract to construct a complete underground conduit system for the Consolidated Electric Light Company, of Maine, at Portland, Me.

Financial Intelligence.

THE WEEK IN WALL STREET.—Bearish influences were prominent on the stock market, and though prices rallied after another exhibition of selling pressure on Thursday, the tone of speculation was unsettled. Liquidation has been very general and the short account has increased materially. United States Steel stocks, though active, followed, rather than led, the rest of the market, rallying easily at the beginning of the week and declining later on on scattered selling by weak or tired holders. There was greater strength in the principal electric stocks, and the electric railways were in good demand at higher prices. Allis-Chalmers common lost a fraction, closing at 14⅜, while preferred is 4 points lower, the last quotation being 50. General Electric made a net gain of 3½ and closed at 174½, and Westinghouse advanced 2½ points, closing at 172½. Electric Storage Battery dropped 2⅞ points net, and closed at 79. A net gain of ⅜-point is credited to Western Union, which closed at 93⅜. Brooklyn Rapid Transit, Metropolitan Street Railway and Interborough Rapid Transit closed with net gains of 1⅛, 1⅝ and ½ points, respectively, the closing quotations being 60⅜, 116⅝ and 202½. The "curb" market was featureless. Quite a number of active issues closed higher, but some others were lower and liquidation apparently continues, taking advantage of each rally to distribute more stock. Following are the closing quotations of May 9:

NEW YORK

	May 2	May 9		May 2	May 9
Allis-Chalmers Co.	15¾	14	Electric Vehicle pfd.	18	18
Allis-Chalmers Co. pfd.	54	51½	General Electric	175¼	175
American Tel. & Cable	91	91	Hudson River Tel.	..	..
American Tel. & Tel.	141	140	Interborough Rap. Tran.	203¼	202
American Dist. Tel.	32¼	30	Metropolitan St. Ry.	118¾	116
Brooklyn Rapid Transit	61½	60¼	N. Y. & N. J. Tel.	172	..
Commercial Cable	..	..	Marconi Tel.	..	..
Electric Boat	34	33	Western Union Tel.	93	93
Electric Boat pfd.	74	74	Westinghouse com.	*172¼	168¾
Electric Lead Reduction	..	..	Westinghouse pfd.	187	..
Electric Vehicle	10	10			

BOSTON

	May 2	May 9		May 2	May 9
American Tel. & Tel	142¼	140	Western Tel. & Tel. pfd	98	98
Cumberland Telephone	119	119	Mexican Telephone	1¼	1¼
Edison Elec. Illum	*252	*250	New England Telephone	138⅜	138
General Electric	175	175	Mass. Elec. Ry	17¼	17
Western Tel. & Tel	17⅛	17⅛	Mass. Elec. Ry. pfd	65⅛	64

PHILADELPHIA

	May 2	May 9		May 2	May 9
American Railways	53	51⅜	Phila. Traction	99¾	99¾
Elec. Storage Battery	80¼	78	Phila. Electric	11⅜	12
Elec. Storage Battery pfd	..	..	Phila. Rapid Trans	33¾	32
Elec. Co. of America	12	12			

CHICAGO

	May 2	May 9		May 2	May 9
Central Union Tel	..	..	National Carbon pfd	118	114
Chicago Edison	160	..	Metropolitan Elev. com	22⅜	21
Chicago City Ry	..	..	Union Traction	..	..
Chicago Tel. Co	..	125	Union Traction pfd	..	.
National Carbon	60	60			

* Asked.

MONTPELIER, VT., LIGHTING.—A deal has just been carried through placing the control of the Consolidated Lighting Company, of Montpelier, Vt., in the hands of W. F. Davidson, A. D. Bennett, G. G. Moore and others of Port Huron, Mich. From small beginnings in the eighties, the Consolidated property was gradually developed with more or less indifferent success, until in 1902 it passed into the ownership of the National Life Insurance Company. That company at once proceeded to supplement the water power at Bolton with a new and modern steam auxiliary plant at Pioneer Falls. The work of designing, building and installing a new station was done under the efficient management of E. P. Coleman, the general manager, and, when completed, the Consolidated property became one of the best equipped and most valuable electric properties in New England. It is now supplying municipal lighting to the cities of Montpelier and Barre and to the town of Waterbury. It furnishes power to the Barre & Montpelier Traction Company and has about 800 other domestic, power, office and commercial customers. The new officers are: President, W. F. Davidson; vice-president, J. C. Tomlinson, of New York; secretary and general manager, J. E. Davidson, formerly with the Port Huron Light & Power Company. It is understood that the recent transaction has been on a cash basis.

EARNINGS IN MILWAUKEE.—The Milwaukee Railway & Light Company reports as follows:

	1905.	1904.		Changes.
March gross	$252,833	$255,670	Dec.	$2,837
Expenses	131,284	142,282	Dec.	10,998
March net	$121,549	$113,388	Inc.	$8,161
Other income	1,297	918	Inc.	379
Total income	$122,846	$114,306	Inc.	$8,540
Charges	74,101	74,050	Inc.	51
March surplus	$48,745	$40,256	Inc.	$8,489
Three mos. gross	740,027	753,484	Dec.	11,457
Expenses	389,027	417,398	Dec.	27,508
Three mos. net	$352,137	$336,086	Inc.	$16,051
Other income	4,585	3,241	Inc.	1,344
Total income	$356,722	$339,327	Inc.	$17,395
Charges	219,643	220,504	Dec.	861
Three mos. surplus	$137,079	$118,823	Inc.	$18,256

INDIANAPOLIS AND TERRE HAUTE INTERURBAN.—Tucker, Anthony & Company, of Boston, have financed and will shortly build a high-speed electric interurban road between Indianapolis and Terre Haute, Ind. It will be known as the Indianapolis & Western Traction Company and will be capitalized at $1,500,000 5 per cent. 20-year first mortgage bonds; $750,000 cumulative 5 per cent. preferred stock and $1,250,000 common stock. The new company will build 52 miles of road and will enter Terre Haute over the lines of the Terre Haute Traction Company, controlled by Stone & Webster, and enter Indianapolis over the tracks of the Indianapolis Railway & Terminal Company, which is owned by the United Gas Improvement Company, of Philadelphia. From the center of Indianapolis to the center of Terre Haute the distance will be 72 miles. P. L. Saltonstall, of Boston, will be president of the new company and S. Reed Anthony treasurer.

INTERBOROUGH NOTE ISSUE.—The Interborough Rapid Transit Company, of New York City, has issued $10,000,000 three-year 4 per cent gold bonds due May 1, 1908. These were bought up by August Belmont & Company, William A Read & Company and Lee, Higginson & Company, who have disposed privately of the entire amount to investors. The reason of this big bond issue appears to be shrouded in mystery. No one connected with the company would say anything at all definite of the purpose to which the $10,000,000 was to be devoted. It is understood that this amount will be devoted to general purposes by the company, such as the completion of the Brooklyn tunnel or to pay the amount due on the Manhattan lease. It has no special significance, either regarding the Bronx extension or the Steinway tunnels, although it may be used partially for these purposes some time later.

NEW ENGLAND TELEPHONE & TELEGRAPH.—Following is a summary of the annual report of the New England Telephone & Telegraph Company for the year ended December 31, 1904:

	1904.	1903.	1902.	1901.
Gross	$7,323,561	$6,092,865	$6,024,610	$5,177,412
Expenses and taxes	5,880,319	4,677,726	4,855,841	4,139,930
Net	$1,443,242	$1,415,139	$1,168,769	$1,037,482
Dividends	1,320,447	1,297,002	1,108,726	947,406
Surplus	$122,795	$118,137	$60,043	$90,076

The gross earnings were $4,361,385.87 and the gross expenses $2,365,328.89, leaving a net profit of $1,996,056.98. The net surplus, after deducting amounts appropriated for interest, insurance, taxes, etc., is $717,357.59.

RECEIVER FOR POWER PLANT.—Justice Kellogg, of the Supreme Court, Saratoga, N. Y., has appointed Charles Pedrick, of Glens Falls, receiver of the Hudson River Water Power Company in the matter of a $2,000,000 mortgage foreclosure action brought by the Hudson River Electric Company. When the application was made it was not claimed that the company was insolvent. The receivership was sought on the ground that it would act as a stay of execution of the judgment of more than half a million dollars secured by the National Contracting Company against the Hudson River concern. The dam and power plant of the company were levied on by the sheriff of Saratoga County several weeks ago, and would have been offered for sale had not the receiver been appointed by Justice Kellogg.

DIVIDENDS.—The second annual dividend of 6 per cent. on the preferred stock of J. G. White & Co., Inc., has been declared, payable June 1. The Niles-Bement-Pond directors have declared the regular quarterly dividend of 1½ per cent. on the preferred stock, payable May 15. Pratt & Whitney directors have declared the regular quarterly dividend of 1½ per cent. on the preferred stock, payable May 15. The Washington, D. C., Railway & Electric Company have declared the regular semi-annual dividend of 2½ per cent. on the preferred stock, payable June 1.

GENERAL ELECTRIC.—The annual meeting of the stockholders of the General Electric Company was held at Schenectady, N. Y., on May 9. The following directors were elected: Gordon Abbott, Oliver Ames, C. A. Coffin, T. Jefferson Coolidge, Jr., W. M. Crane, Fred P. Fish, George P. Erdner, Eugene Griffin, T. K. Henderson, Henry L. Higginson, J. Pierpont Morgan, J. P. Ord, Robert Treat Paine, Second, E. W. Rice, Jr., and Charles Steele. The directors will meet shortly and elect officers. The annual report has already been published in these pages.

HAWAIIAN ISLAND PROJECT.—Deeds have recently been recorded at Honolulu, Hawaii, by which the financing of the Kauai Electric Company will be carried out with the aid of the McBryde Sugar Company. Over $200,000 will be spent on the plant. The plantation is to pay about $36,000 per year for the power and water. The McBryde Company also pays over $150,000 of its second issue of bonds, and guarantees $150,000 of the electric company's bonds.

CINCINNATI GAS & ELECTRIC.—The annual report of the Cincinnati Gas & Electric Company shows a gain in electrical output equivalent to 60,778 incandescent lights of 16 candle-power. The number of consumers of electric energy increased 1,200. It is understood that the company earned about 5 per cent. on its $3,000,000 of capital. The directors and officers were re-elected.

WEST END STREET RAILWAY BONDS.—The treasurer of the West End Street Railway Company, Boston, sold an issue of $200,000 4 per cent. 30-year gold bonds dated August 11, 1902, to Hayden, Stone & Company. The money realized from the sale of these bonds will be used to retire an issue of Boston Horse Railway Company 5 per cent. bonds maturing May 1.

ROCHESTER & SYRACUSE RAILROAD.—The Rochester & Syracuse Railroad Company, which is building an electric road from Rochester to Syracuse, has applied to the State Railroad Commission for authority to increase its capital stock from $1,000,000 to $3,000,000 and to issue $7,500,000 bonds. The State Commission reserved its decision.

LAKE SHORE DEAL.—A deal has been consummated, by the terms of which the banking houses of C. D. Barney & Co., of Philadelphia and New York, acquire the remaining $1,400,000 first consolidated 5 per cent. gold bonds of the Lake Shore Electric Railway, the other $350,000 having been previously acquired.

KANSAS MORTGAGE.—A mortgage has been filed in Kansas City, Kan., for $2,000,000 to cover money advanced by the Trust Company of America, of New York, for the construction of the Kansas City & Bonner Spring Electric Railway.

General News of the Week

The Telephone.

PHOENIX, ARIZ.—The Sunset Telephone, Telegraph & Electric Company has acquired by purchase the franchises and equipment of the Gila Valley telephone system.

FORT SMITH, ARK.—A new telephone line is now being completed between Muskogee, I. T., and Fort Smith, Ark., by the Pioneer Company, which will give Shawnee telephone connection with Fort Smith and practically all other points in Arkansas. The Pioneer Telephone & Telegraph Company is also building a line betweeen Tulsa, I. T., and Coffeyville, Kan., that will afford connections with the oil fields. The company has purchased a line between Coffeyville and Wagoner, I. T. Material is now arriving to build a new direct copper circuit between Shawnee and Ada, I. T. The Pioneer Company has recently established connections over heavy copper circuits with St. Louis and Kansas City, and talk has been successfully carried on as far east as Cincinnati.

SAN DIEGO, CAL.—The National City board of trustees has received a petition of the Home Telephone Company for a franchise to construct and operate telephone lines in National City.

SAN FRANCISCO, CAL.—The Pacific States Telephone & Telegraph Company, which is erecting several large steel-frame brick buildings in this city, including a new central telephone exchange on Bush Street, near Kearny, will make a test of its new multiple switchboard at once, at the new East office. The Sutter, Hyde, Polk and Larkin Street lines are all combined in this office now. This is preparatory to changing the entire San Francisco system over to the central energy multiple switchboard plan of operation on the completion of the remaining buildings. The proposed competition of a new company, promoted by officers of the Home Telephone Company, of Los Angeles, is stimulating the activity of the Pacific States officials.

DENVER, COLO.—The Colorado-Wyoming Telephone Company has filed articles of incorporation in the office of the Secretary of State. The company is a Wyoming corporation and conducts a telephone system in northern Colorado and southern Wyoming. The filing was made in connection with the appointment of T. C. Williams, of Greeley, as the agent.

MEADOWS, IDAHO.—The Meadows-Warren-Roosevelt Telephone Company, which proposes to build a line connecting these and other cities, has been organized here, with a capitalization of $20,000.

SPRINGFIELD, ILL.—The Sangamon Telephone Company has increased its capital stock from $25,000 to $60,000.

CHICAGO, ILL.—The Chicago Telephone Company reports a gain of 1820 telephones for April. The total now in use is 125,208.

TAYLORVILLE, ILL.—The Home Telephone Company of Taylorville has been granted a franchise by the City Council and will install a modern telephone system here. The company is capitalized at $50,000.

BELLEVILLE, ILL.—The Marissa Farmers & Merchants' Telephone Company has filed papers of incorporation. The capital stock is $10,000 and the incorporators are G. W. Nevins, S. S. Boyle, W. E. Meeks and J. A. Hamilton.

BLOOMFIELD, IND.—The directors of the New Home Telephone Company will improve and extend the system. Earl Talbott, of Linton, is manager.

NEW SALEM, IND.—The New Salem Telephone Company has been formed with a capital of $5000. The incorporators are William P. King, John O. Williams and others.

TERRE HAUTE, IND.—Articles of incorporation of the Sanford Mutual Telephone Company have been filed. The incorporators are Josiah D. Wolfe, C. A. Ray and others. The capital is $5000.

CLARENCE, IA.—The Clarence Telephone Company will erect an office and exchange building in this city soon.

WATERLOO, IA.—The United States Telephone & Telegraph Company has been sold to Thomas Cascaden, representing a syndicate of Waterloo men, for the sum of $55,000. The company's lines cover Black Hawk, Grundy, Butler, Chicksaw, Bremer, Buchanan, Franklin, Cerro Gordo, Floyd, Benton, Tama, Marshall and Fayette counties.

COLDWATER, KAN.—The Coldwater Telephone Company of this city has been incorporated with a capital of $1,500.

EMPORIA, KAN.—W. W. Finney, son of ex-Governor Finney, has purchased a controlling interest in the Emporia Independent Telephone Company and will at once assume control.

LONDON, KY.—A new telephone company has just been organized with W. W. Rawlings, of Manchester, as president, and Judge H. C. Faulkner, of Barbourville, and John Woodward, of this place, principal shareholders. The company is to be incorporated with a capital stock of $5,000. It will build from Burning Springs, Clay County, to Booneville, Owsley County, where an exchange will be put in. Lines are also to be built from Booneville to Beattyville, to St. Helens and to Heidelburg.

TRUMP, MD.—The Union Telephone Company of this city has increased its capital from $3000 to $10,000, and will extend its line.

BALTIMORE, MD.—The Hotel Rennert Company has made arrangements with the Chesapeake & Potomac Telephone Company for the installation of a private branch exchange of over 300 stations to be distributed throughout the hotel.

ELMIRA, MICH.—The Hayes & Elmira Telephone Company has been organized to operate rural lines in Otsego County.

DETROIT, MICH.—Between $15,000 and $16,000 will be spent in the next 90 days for the improvement of independent telephone toll line service between Detroit and Lansing, Detroit, Ann Arbor and Jackson, Detroit and Northville and Detroit and Holly. New double-copper circuits will be installed, and in all 480 miles of copper wire strung. The work between Detroit and Lansing will be done by the Peninsular Telephone Company, Detroit; Livingston County Telephone Company, Howell, and the Citizens' Telephone Company, Lansing; between Detroit, Ann Arbor and Jackson, Peninsular Telephone Company, and the Washtenaw County Telephone Company, Ann Arbor; between Detroit and Northville, the Peninsular Telephone Company; between Detroit and Holly, the Peninsular Telephone Company. R. B. McPherson, of Howell, president of the Livingston County Telephone Company, was elected president, and F. H. Howard, of Flint, auditor of the Valley Telephone Company, secretary. President McPherson was chosen as delegate to the national convention of independent telephone associations, to be held June 21, at Chicago.

DULUTH, MINN.—The Duluth Telephone Company will install a common battery system at West Duluth, Old Superior and at Virginia. A 300-line board has been installed at West Duluth and an additional 660-line board will be installed at the central office here.

JOPLIN, MO.—The Home Telephone Company has increased its capital from $200,000 to $750,000.

PLEASANT HILL, MO.—The Pleasant Hill Telephone Company has increased its capital stock from $10,000 to $30,000, one-half of the increase being paid.

BILLINGS, MONT.—The Rocky Mountain Bell Telephone Company will build extensions to the long-distance service, ultimately reaching Williston, N. D.

DESPATCH, N. Y.—The Bell Telephone Company is constructing a new line from Penfield Village north along the Five-Mile line to Kennedy's Corners, then west to the Sperry Mills.

WHEATLAND, N. D.—It is reported that the Tri-State Telephone Company will build west to this place. A local exchange is also projected.

CIRCLEVILLE, OHIO.—The Citizens' Telephone Company of this city has increased its capital stock from $64,000 to $200,000.

GENEVA, OHIO.—A franchise has been granted to the Bell Telephone Company for the erection of an exchange in this city.

FULTON, OHIO.—The Fulton Telephone Company of this city has reduced its capital and the number of directors. H. L. Becker, secretary.

ORRVILLE, OHIO.—The name of the Gemmill Telephone & Mfg. Company has been changed to the United Telephone & Switchboard Company.

WARREN, OHIO.—The directors of the Warren & Niles Telephone Company have passed a resolution providing for the extension of its lines at Bristolville, North Bloomfield and possibly to Orwell.

BURLINGTON, OHIO.—The Burlington Telephone Company has been incorporated with a capital stock of $300. The incorporators are Rachel Dillon, Clayte L. Crawford, John E. Banks, Wilson Pritchard and Henry Konns.

ATHENS, OHIO.—The Athens County Home Telephone Company has been incorporated with a capital stock of $100,000. The incorporators are W. E. Peters, J. E. Williams, H. D. Henry, H. W. McKinstry and A. E. Ayres.

NEW BREMEN, OHIO.—The village of New Bremen is in an electric light franchise trouble. The electric light plant is owned by J. D. S. Neely, of Lima, and D. W. Jay, of St. Mary's, and the present franchise expires May 1. The owners, who have operated the plant for the past five years, want the franchise renewed for five years, while the corporation council declares it will grant but one year. Messrs. Neely and Jay say they will leave the town in darkness May 1 unless the franchise is extended, and the citizens are debating the question of seizing the plant and trying municipal ownership.

GAGE, OKLA.—The Gage Telephone Company has been incorporated with a capital stock of $5000. The incorporators are Dr. G. E. Irwin, R. I. Bishop, L. L. Pryor, E. Leonard and R. D. Cole.

FINESVILLE, PA.—A new telephone company to operate in this and adjoining counties has been organized with offices at Finesville. The company will be known as the Mutual Telephone Company. The following officers have been elected: President, Dr. Charles H. Boyer; treasurer, W. I. Jacoby; secretary, W. B. Laubach.

ELKHORN, S. D.—A telephone line 35 miles long is being built between Rapid City and Mystic, and the townsite of Elkhorn, the new town half a mile below Silver City.

PRINGLE, S. D.—Articles of incorporation have been filed for the Pringle Telephone Company at Pringle, Custer County, with a capital of $10,000. Incorporators are Patrick M. Conlon, Joseph F. Conlon and others.

BIG SPRINGS, TEX.—The Western Telephone Compapny has filed an amendment to its charter, increasing its capital stock from $30,000 to $60,000.

LOYAL, WIS.—The Beaver Telephone Company, of Loyal, has been formed, capital $400. The incorporators are B. F. Frazier, D. A. Irvine and others.

LA CROSSE, WIS.—The La Crosse Interurban Telephone Company has just consummated a deal which will result in an important extension of its lines through the counties of Vernon, Crawford and Richland.

Electric Light and Power.

TUSCUMBIA, ALA.—The Mussel Shoal Electric Company has been organized with a capital of $10,000 for the purpose of supplying electric light and power, heat, etc., from Mussel Shoals. The incorporators are Thos. H. Jackson, Memphis, Tenn., Jas. Jackson, of Tuscumbia, and others.

YELLVILLE, ARK.—Isaac Emery has petitioned Council for a franchise for an electric light plant.

VENTURA, CAL.—It was voted April 22 to construct water works and an electric light plant.

SANTA BARBARA, CAL.—The Edison Company will establish a 1500-hp motor generator at its local plant, and is to run a line shortly from the immense Kern River plant to Santa Barbara.

MADERA, CAL.—A Merced company is desirous of furnishing electric light and power to Madera, and will invest a capital of $100,000. The proposition has been brought to the notice of the Madera Board of Trade.

SANTA BARBARA, CAL.—The Merchants' Mutual Electric Light Company is being formed by the merchants of Santa Barbara in opposition to the Edison Company and is now ready to commence the construction of its plant.

STOCKTON, CAL.—Leopold Wallach, of New York, has placed a $5,000,000 bond issue for the Stanislaus Electric Power Company. The company is to build a power plant at Murphys and supply energy to Stockton, San Jose and San Francisco. It will generate, if necessary, 24,000 horse-power for light and power purposes. Work on the new plant has commenced.

SEBASTOPOL, CAL.—Sealed bids will be received by Wm. T. Searles, town clerk of Sebastopol, June 6, for a franchise to construct and operate poles, wires, transformers and other conductors for the transmission of electricity for electric light and power purposes and to operate electric light and power systems there, as applied for by the Sebastopol Light, Power & Water Company.

SAN FRANCISCO, CAL.—At the annual meeting of the San Francisco Gas & Electric Company, the old board of directors was reelected. There was no change made in the officers of the company, who are W. B. Bowen, president; A. H. Payson, first vice-president; C. Osgood Hooker, second vice-president, and Charles L. Barrett, secretary and treasurer. The president's report for the year ending December 31, 1904, showed that the company's revenue amounted to $4,393,277.68, against an operating and maintenance expenditure of $2,064,926.35. Fixed charges for taxes ($118,065.08) and bond interest ($444,852.50) amounted to $562,917.58. Depreciation, replacement, contingent and other necessary funds were credited the sum of $700,000, leaving $1,065,433.75 net available profit for the year. The dividends paid during the year amounted to $792,421.68, leaving a net surplus of $273,012.07 at the close of 1904. By the end of the present year the concentration of nearly all of the engine-driven units in the Potrero electric power station will have been accomplished. The Jessie Street plant is being rebuilt as a model sub-station and by the middle of next year its last remaining steam engine will have been removed. About 2,000 hp. is being purchased under contract from the Standard Electric transmission line, owned by the California Gas & Electric Corporation.

GLASTONBURY, CONN.—A large power plant is now being installed at the factory of the J. B. Williams Company at Glastonbury. There will be two generators, one of 200 horse power and one of 100 horse power.

MERIDEN, CONN.—The Connecticut Electric Equipment Company of this city, has just completed the installation of one of the finest electric factory power plants in the State at the Wilcox & White shop. All the heavy shaft ing and belting have been removed and electric wire substituted.

WILMINGTON, DEL.—The Wilmington Electric Light, Heat & Power Company has been formed; incorporators, Horace W. Gause, Samuel K. Smith, Charles C. Kurtz, H. P. Scott, all of Wilmington, George R. Webb, Baltimore; capital, $1,000,000.

WASHINGTON, D. C.—Bids will be received by Lieut. Col. Smith S. Leach, Corps Engineers, U. S. A., May 20, for furnishing and installing a complete electric lighting equipment for the Washington filtration plant.

ST. AUGUSTINE, FLA.—Gen. Foster has petitioned Council for a franchise for an electric light plant.

OCALA, FLA.—The Florida Power Company has been incorporated with a capital of $300,000 by W. N. Camp, R. F. Brewer, G. D. Munsing and others.

MONROE, GA.—The town of Monroe has voted a bond issue for a new electric light plant.

PELHAM, GA.—The City Council has granted W. H. Maury a franchise for an electric light plant.

OCILLA, GA.—The City Council has decided to call an election to vote on issuing $20,000 bonds for water works and an electric light plant.

AUSTELL, GA.—It is proposed to construct an electric light plant to cost from $2500 to $3000. No engineer has been selected as yet. C. J. Shelverton is Mayor.

COVINGTON, GA.—The City Council has approved the plans of the White Shoals Power Company for lighting the city from its proposed plant on Alcovey River, 10 miles southeast of the city.

NOKOMIS, ILL.—The Henry Electric Light & Power Company, of Nokomis, has been incorporated, with a capital of $20,000 by John H. Crickenberger, Fred W. Potter and Chas. A. Anyum.

FLORA, IND.—Dr. Ross, of Wabash, is interested in the construction of an electric light plant at Flora.

CONNERSVILLE, IND.—The Connersville Light, Heat & Power Company will expend about $25,000 in improvements.

LAFAYETTE, IND.—The Lane & Pike Company, of Lafayette, has secured the contract for the reconstruction of the power house and heating plant at the State Soldiers' Home for $35,060.

ELKHART, IND.—By the sale, on April 26, of the Elkhart Citizens Electric Company's plant to Charles A. Gapen, presumably representing the Hen Island dam electric syndicate, the bitter rivalry of years is ended. The consideration is about $250,000 less than what the plant cost. It is estimated that Col. Conn has lost at least $100,000 by his venture.

MONTICELLO, IND.—The Tippecanoe Hydraulic Company has been organized to utilize the water power of Tippecanoe River; capital $800,000. It is proposed to construct four power plants: one at Norway, another at Tioga, another at Oakdale and the fourth at Springboro. Work is about to begin at the plant at Norway which will cost about $195,000. The company proposes furnishing power to Lafayette, Logansport and Frankfort. A. A. McKain, of Indianapolis, and C. D. Meeker and D. W. Thompson, Jr., of Frankfort, are interested.

WINFIELD, KAN.—The citizens have voted to issue $13,000 bonds to complete the electric light plant.

TOPEKA, KAN.—The question of combiing the city electric light plant with the Harrison Street pumping plant of the water works is under consideration.

GEORGETOWN, KY.—The Georgetown Water, Gas, Electric Light & Power Comapny has been reorganized. It will add a steam heating plant and a new gas plant.

PADUCAH, KY.—David G. Wright, of St. Louis, Mo., and other St. Louis and New York capitalists are interested in the construction of an electric light and power plant here, to cost from $300,000 to $500,000.

LAKE CHARLES, LA.—The City Council has decided to call an election to vote on issuing $60,000 bonds to build a municipal electric light plant or purchase the plant of the local electric light company.

SHREVEPORT, LA.—J. F. McCulloch, of St. Louis, Mo., estimates the cost of constructing a municipal electric light plant at $171,000. This provides for a plant with a capacity of 10,000 incandescent lights of 16 candlepower each and 200 street arcs of 2000 candle-power each.

NORTHAMPTON, MASS.—The Northampton Electric Lighting Company has placed an order with the Buckeye Engine Company, of Salem, Ohio, for a tandem compound engine of 625 horse-power, to take the place of a 100-hp Corliss engine.

FALL RIVER, MASS.—The stockholders of the Fall River Electric Light Company have voted to increase the capital stock from $350,000 to $600,000, the increase to be used for the construction of a new generating plant on the company's wharf property and also to extend its system of distribution.

QUINCY, MASS.—At a meeting of the City Council of Quincy an order was adopted requesting the Mayor to appear before the Massachusetts electric light and gas commissioners and endeavor to secure a reduction in the prices charged for electric lights by the Quincy Electric Light & Power Company.

WELLESLEY, MASS.—The town has decided not to build a municipal lighting plant, but will break away from a contract with the Edison Company, which has been supplying electric light for several years, and buy its electric supply from Vincent Goldthwaite, of Wellesley. For this work $32,000 is now available.

PORTLAND, ME.—G. M. Gest, of New York, and Cincinnati, Ohio, has secured the contract for constructing a complete underground conduit system for the Consolidated Electric Light Company, of Maine, at Portland.

ROSE CITY, MICH.—The Rose City Mfg. Company is figuring on installing a city electric light plant.

MELROSE, MINN.—Oscar Claussen, of St. Paul, will prepare plans for the proposed water works and electric light plant. The probable cost of work will be $30,000.

BRECKENRIDGE, MO.—The citizens have voted to issue $10,000 bonds for the construction of an electric light plant.

NIAGARA FALLS, N. Y.—The Niagara power bill was defeated in the Assembly Rules Committee.

OSWEGO, N. Y.—Bids will be received by the Department of Water, May 18, for furnishing the necessary generators, motors, transformers and other electrical equipment for the Lake water extension.

YONKERS, N. Y.—The Lawrence Park Heat, Light & Power Company has been incorporated with a capital stock of $50,000. The directors are W. V. D. Lawrence, J. J. Lannin and A. W. Lawrence, New York.

ALBANY, N. Y.—The Northern Westchester Lighting Company, of Ossining, has been incorporated to supply gas and electricity for light, heat and power purposes. The capital stock is $1,000,000, and the directors are William J. Bagnell, Louis B. Grant and James H. Haggerty, of Brooklyn; Charles T. Lark and Ashley T. Cole, of New York, and Alexander Keogh, of New Rochelle.

WAYNESVILLE, N. C.—The citizens have voted to install a system of electric lighting.

FAYETTEVILLE, N. C.—The citizens have voted to issue $30,000 bonds for enlarging the electric light plant.

KINGS MOUNTAIN, N. C.—The citizens have voted to issue $15,000 bonds for the construction of an electric light plant.

OXFORD, N. C.—The Oxford Water & Electric Company has been chartered with $100,000 authorized capital to furnish water, light and power. The incorporators are Harry L. Millner, of Morganton, N. C., and Washington, D. C., capitalists.

WILLISTON, N. D.—D. C. Page, City Auditor, writes that the subject of constructing water works and an electric light plant will probably be taken up in about 30 days.

READING, OHIO.—Contracts will probably be let in June for improvements to the water and light plant to cost about $27,000. B. A. Burns is superintendent.

SPRINGFIELD, OHIO.—The Peoples' Light, Heat & Power Company is about to let contracts for improvements to cost about $150,000. Charles Johann is the engineer.

COLUMBUS, OHIO.—The Columbus Public Service Company will increase its capital an additional $250,000 to be used in enlarging the plant at 17th and Mound Streets and in extending the hot-water system into sections on the East Side.

HAMILTON, OHIO.—The Hamilton Gas & Electric Company will expend about $500,000 in improving the plants recently acquired through a merger of the Hamilton-Otto Coke Company, the Hamilton Electric Light Company, and the Hamilton Gas & Coke Company. The improvements will include a new electric plant, new overhead construction for electric service and general enlargement of the three plants.

ELYRIA, OHIO.—The stockholders of the Ford Light & Heating Company have organized. The stockholders elected the following named officers: J. C. Hill, president; E. A. Berry, vice-president; L. B. Fauver, secretary; J. C. Smith, treasurer; E. E. Martin, assistant treasurer. The company will move its plant to Elyria from Garretsville where it was formerly known as the Ford Lighting Company. The capital stock has been increased from $25,000 to $50,000.

YORK HAVEN, PA.—The York Haven Water & Power Company has decided to extend its lines to Lancaster County and in Dauphin County.

TOWER CITY, PA.—H. T. Bressler is completing arrangements to construct an electric light plant to light Tower City, Williamstown, Lykens, Wiconisco, Reinarton, Johnstown and Reiner City.

FRACKVILLE, PA.—The directors were elected at a meeting of the stockholders of the Frackville & Gillerton Light, Heat & Power Company. The officers are: President, David Taggart; secretary, C. A. Bleiler; treasurer, L. C. Anstock.

PHILADELPHIA, PA.—Bids will be received until May 22 by Lieut. Col. Frank Heath, Commanding, for furnishing supplies during the year ending June 30, 1906, for the Frankford Arsenal, Philadelphia, as follows: Electrical supplies, steel, iron, iron bronze, steel and aluminum castings, tin, zinc, lead and antimony; plumbing, steam fitting, etc.

PITTSBURG, PA.—The contract for the electrical construction work and apparatus for the filtration plant being constructed at Aspinwall has been awarded to the Morganstern-Ochiltree Company, of Pittsburg. It includes the installation of a complete power and lighting system, telephone exchange, police and time-clock systems. All the power, lighting and telephone cables will be placed underground, the conduits to include cables sufficient for supplying about 20,000 lights.

YORK, PA.—The Hillside Water & Power Company and the Susquehanna Water & Power Company have been merged into McCall's Ferry Water & Power Company. The merger is taken to mean that an electric power plant will be installed at McCall's Ferry in the near future. These two companies, while chartered at nominal figures, have invested thousands of dollars in lands adjoining the river shores. They have secured every tract of land for miles up and down the river and have hundreds and thousands of dollars tied up until a plant is built and power is being furnished to the large cities. It is stated that New York capitalists are interested. The location of the plant will make it possible to supply current to Baltimore, Wilmington, York, Havre de Grace and Philadelphia.

CENTRAL FALLS, R. I.—This city contemplates the construction of a municipal heat, light and power plant for 185 arc lights and 500 incandescent lights. Wm. H. Goldsmith is clerk of the lighting committee.

ORANGEBURG, S. C.—The commissioners of public works of Orangeburg have been instructed to secure information as to the best machinery, etc., for improving the lighting system. About $5,000 is to be expended.

MARBLE FALLS, TEX.—M. H. Reed is interested in the construction of an electric light and power plant to be constructed here at a cost of $160,000. No engineer has been chosen yet.

NEWMARKET, VA.—The Council has granted Rice Snapp a franchise to construct and operate an electric light plant.

ASHLAND, VA.—Bids will be opened on May 18 for a franchise for an electric light plant. Chas. Stebbins is City Secretary.

BRISTOL, VA.—Bids will be received May 10 by Pres. J. W. Mort for a franchise to operate electric light and power plants in Bristol.

MONTPELIER, VT.—The Consolidated Light & Power Company, of this city, has been transferred to Wilbur F. Davison, A. D. Bennett, George Moore, of Port Huron, Mich., and some Eastern associates. The sale was made on a cash basis for about $200,000. The company's system extends from Bolton Falls, 12 miles below this city, to the granite quarries in Barre. It supplies municipal lights for Montpelier and Barre, besides a large number of private lights, and furnishes power for the electric railway and several granite plants. The property has been in the hands of the National Life Insurance Company for some years.

UNIONTOWN, WASH.—M. J. Shields, of Moscow, Ida., has petitioned for a franchise for an electric light plant.

PROSSSER, WASH.—The Prosser Falls Land & Power Company has decided to develop the water power of Columbia River at Priest Rapids.

GOLDENDALE, WASH.—H. W. Fellows, of Spokane, is interested in the construction of an electric light plant at Goldendale, to cost about $50,000. Power is to be developed from the falls of the Little Klickitat.

MARLINTON, W. VA.—The Marlinton Light & Water Company proposes constructing water works and an electric light plant here.

BURLINGTON, WIS.—In regard to the construction of an electric light plant, for which the citizens recently voted to issue $8,000 bonds, the Council is taking steps to construct a plant with a capacity of fifty 2,000 candle-power arc lamps.

MONTREAL, CAN.—The Montreal Light, Heat & Power Company has had its franchise for supplying all gas in Montreal extended for fifteen years.

NAPANEE, ONT.—It is proposed to construct a municipal electric light plant to cost about $40,000, but nothing definite has yet been done. W. A. Grange is town clerk.

PARRY SOUND, ONT.—It is proposed to install a 400-kw, 2080-volt, 60-cycle, 3-phase revolving field alternator; also switchboard and a 22-kw, 125-volt exciter with water wheel; also a water wheel governor.

The Electric Railway.

ATLANTA, GA.—The preliminary survey for the proposed Atlanta-Macon Interurban Railway will be commenced immediately. Charles J. Canfield, of Chicago; Charles W. Swigert, of Manistee, Mich., and Mr. Williamson, of Indianapolis, are backing the project.

BOISE, IDA.—W. F. Pierce, promoter of the electric railway from this city to Pearl and Caldwell, states that the road will positively be built, and that an engineer will soon be sent to Boise to check up the surveys, preparatory to beginning active work.

CRAWFORDSVILLE, IND.—John Bonnell and H. W. McAffee, of this city, are interested in a plan to build an electric railway from Lafayette to Terre Haute.

EVANSVILLE, IND.—The Evansville & Newberg Electric Railway was opened for business May 6. This is a reconstructed and electrified railway formerly operated as a dummy line.

INDIANAPOLIS, IND.—The new owners of the Indianapolis & Western Railroad, now building between Indianapolis and Terre Haute by way of Danville, Greencastle and Brazil, have elected the following officers: President, P. J. Saltonstall, of Boston; vice-president, George L. Townsend, of Indianapolis; treasurer, S. R. Anthony, of Boston; secretary, Pierre Gray, of Indianapolis; chief engineer, Robert P. Wood, of Indianapolis.

BUTTE, MONT.—It is reported that the Oregon Short Line may equip the 60-mile Minidoka branch of railroad with electricity. The Union Pacific has three electric locomotives which will be transferred to the Minidoka branch if experiment is carried out.

NEW YORK, N. Y.—The Rapid Transit Commission has rejected the plan for a moving platform under Thirty-fourth Street. It decided to map out a four-track railroad under Thirty-fourth Street from Third Avenue to Seventh Avenue, where it will tap the new Pennsylvania terminal. The successful bidders for the route will be allowed to continue it to the North River and on the East Side to the Thirty-fourth Street ferry. This action is really in favor of the Metropolitan interests.

ROME, N. Y.—At the meeting of those interested in a new electric railway from Rome to Oneida, it was decided to organize the Rome & Oneida Electric Railway Company with a capital stock of $150,000. The following will be the stockholders: DeWitt C. Hadcock, Oneida; L. Mittenmaier, Jr., A. R. Kessinger, James A. Bailey, Dr. Charles Bernstein and others, of Rome. The managing directors will be DeWitt C. Hadcock, Mittenmaier, Larkin, Kessinger, Soper, Bernstein, Maycock, John Hadcock and Bailey.

WINSTON-SALEM, N. C.—The proposition for Winston-Salem to issue bonds to the amount of $37,500 for the building of an electric railway between this city and High Point, a distance of 20 miles, was carried in the election held a few days ago. High Point has raised $37,500 and the promoters of the road say that work on it will begin at once.

ASHEVILLE, N. C.—It is said that an issue of $750,000 bonds will shortly be placed on the market by the Asheville & Burnsville Electric Railway Company, of which George D. Mills, of Warsaw, Ind., is president. This road will be built largely for freight purposes and will have located along the route more big lumber plants perhaps than any road of similar extent in the South.

WILMINGTON, OHIO.—J. C. Spaite is promoting an electric railway to extend from Wilmington to Spring Valley, where connection will be made to Dayton.

GALION, OHIO.—W. L. Ball, promoter of the Galion Southern Electric Railway, claims that he has secured practically all the right of way for the line from Galion to Fredericktown.

HAMILTON, OHIO.—Fred J. Carr, of Toledo, is promoting the Ohio & Indiana Traction Company, which proposes to build from Hamilton to Richmond, Ind., a distance of 45 miles.

GALION, OHIO.—T. A. Gruber, of Caledonia, representing the Columbus, Delaware & Marion Railway, is securing right of way for an extension of the line from Marion to Galion.

CINCINNATI, OHIO.—The Cincinnati, Dayton & Toledo Traction Company has increased its capital stock from $5,000,000 to $5,250,000. The increase is in new preferred stock which will be sold to pay off the floating indebtedness before the road is turned over to the Elkins-Widener Leasing Company.

MOUNT JOY, PA.—The Town Council has passed the ordinance granting a franchise to the Lancaster, Rohrerstown & Mount Joy Electric Railway Company.

NEW CASTLE, PA.—A merger of the Pennsylvania & Mahoning Valley and the New Castle & Sharon Interurban Electric Railway has practically been effected, the amount of capital involved being fully $2,500,000.

PHILADELPHIA, PA.—It is stated that the Philadelphia Rapid Transit Company will soon award the contract for constructing an addition to its power house on Wyoming Avenue, near Third Street to cost $20,000. W. S. Twining is chief engineer.

ERIE, PA.—The Benton Harbor & St. Joseph Electric Railway & Light Company, controlled by Erie capitalists, has been purchased by James Mc-

Michaels, president of the St. Joseph River Traction Company, and C. K. Minary, of Springfield, Ill. The new management will expend a large sum in developing the system.

WEST CHESTER, PA.—The West Chester, Uwchlan & Pottstown Electric Railway has received a charter from the State to build a line from West Chester to Pittstown. The directors and stockholders of the company are: President, C. Wesley Talbot, West Chester; Bayard A. Conard, Font; Horace A. Fetters, Uwchlan; W. R. Morgan Root, James H. Morris, Pittstown; John M. Plank, B. F. Green, West Goshen, and Harvey W. Krauser, Font.

COLUMBIA, S. C.—The Northern and local capitalists who recently purchased the street railway have completed arrangements to acquire a large kindred concern, the Columbia Water Power Company, which furnished 9,000 electrical horse power to the street railway, cotton mills and other manufacturing concerns. The new property is to be greatly improved, thus enabling extensions to be made in the street railway lines. The power capacity is to be increased by the addition of three large new generators, which will give 3000 horse-power more.

BRYAN, TEX.—The City Council has granted franchises to W. P. Connelly, J. W. Batts, J. Allen Myers, G. M. Brandon and J. R. Austin to construct and operate an electric railway over the streets of Bryan; also to erect and operate an electric light plant.

NORTHAMPTON, VA.—The Kingston, Brighton & Northern Railroad Company of Northampton has been chartered. It has the right to operate by electricity or steam near Cape Charles, Va. W. E. Dickinson, of New York, is president. The capital is $100,000.

NEW MARTINSVILLE, W. VA.—The Wetzel-Tyler County Street Railway has received a franchise from the Town Council of this place. The company has been operating between New Martinsville and Sistersville for some time, but has never been given the right to enter this city.

New Industrial Companies.

THE LAFAYETTE ELECTRICAL MANUFACTURING COMPANY, of Lafayette, Ind., whose incorporation was recently announced, has a capital stock of $35,000. The incorporators are Thomas Duncan, Robert L. Jaques and Edward F. Bohrer.

THE GEORGE CUTTER COMPANY has been incorporated at South Bend, Ind., with a capital stock of $10,000. The company will manufacture electrical supplies and specialties. The directors are George Cutter, I. M. Cutter and Albert Scheible.

THE TELEGRAPHONE COMPANY OF AMERICA has been incorporated under Maine laws with $10,000,000 capital, 100,000 shares, par $100. Nothing, however, is paid in. The company proposes to manufacture, buy and sell telegraphonic and telephonic instruments, phonographs and graphophones.

THE SUNDERLAND MANUFACTURING COMPANY, recently organized with a capital stock of $25,000, will establish a plant at Tilton, N. H., for the purpose of manufacturing brass furnishings for upholsterers, gas and electric light fixtures, small brass parts for automobiles, etc. B. S. Cotes, of Tilton, is president of the company.

Legal.

MUNICIPAL STREET RAILWAYS.—The city of Chicago has won a victory in traction litigation, bringing municipal operation a step nearer. Judge Grosscup, of the Federal District Court, has denied a motion on behalf of the Union Traction Company to enjoin the city from interfering with the use of the so-called Adams Street line of the old Chicago Passenger Railway Company. Judge Grosscup said that he had withheld the decision for a considerable time, believing that it would hinder rather than help negotiations for an agreement between the city and the traction interests, but that as soon as he was officially informed that negotiations had been balked, he framed his decision. The court holds that the franchise of the Chicago Passenger Railway Company expired in April, 1904. With the way cleared by the decision, it is the intention of the city administration to use the Adams Street line as a beginning for a municipal street railway system.

RIGHT TO TICKER QUOTATIONS.—The Supreme Court of the United States has decided the case of the Board of Trade of Chicago against the C. C. Christie Commission Company of Kansas City and the Kinsey Company of Chicago, involving the question as to the right of the private concerns to use the continuous quotations of the board, in favor of the contentions of the Board of Trade. There were two cases in which the point was raised, one of them being entitled the Board of Trade vs. the Christie Company, of Kansas City, and the other the Kinsey Company, of Chicago vs. the Board of Trade, but the question involved was the same in each case, and both involved efforts to enjoin the private establishments from the use of the board's quotations. Both concerns resented the use of the designation of bucket shop, and it was charged that the transactions of the board are themselves of a nature to justify the characterization of the board as a bucket shop, a majority of them involving no physical transfer of the property supposed to be transferred. Summing the points involved, Justice Holmes, in delivering the opinion of the court, related that the board supplies its quotations to the telegraph companies under a contract not to deliver them to bucket shops, and said the cases were instituted to prevent the use of the figures by the private houses without contracts with the Board of Trade. He added that a majority of the court was not prepared to say that the transactions of the board constitute gambling and the decision was that the injunction should be granted as prayed for. Justices Harlan, Brewer and Day dissented.

Personal.

MR. BASSETT JONES, JR., will be married May 20, at Westfield, N. J., to Miss Emma Marion Starr.

MR. W. L. DRIESBACH, of Easton, Pa., has brought the entire property of the Watkins, N. Y., Gas & Electric Light Company.

MR. J. T. BAKER has been made district manager for the Aurora, Ill., Division of the plants of the Western United Gas & Electric Company.

MR. W. H. COLE, chief engineer for some time past with the Goldschmidt Thermit Company, has resigned and will take up electric railway work in Europe.

MR. L. E. JEANNIN will start an electrical contracting and supply business at Ottumwa, Ia., not at Orlando, Fla., as was erroneously stated in our issue of April 22.

MR. A. S. HALLE, of the business staff of the Denver Gas & Electric Company, has become associated with the business department organized recently by the Consolidated Gas Company of New Jersey.

MR. FRANK H. TAYLOR, head salesman of the Westinghouse Electric Manufacturing Company, is visiting San Francisco on business connected with the changes in the management of the San Francisco office.

MR. R. F. KELKER, assistant not long since to the general manager of the Brooklyn Heights Railroad, has become engineer of the Goldschmidt Thermit Company and will superintend the street railway department.

MR. CHESTER I. CAMPBELL, manager of the International Electrical Exhibition, Boston, in July is visiting electrical people in New York, Philadelphia, Baltimore and Pittsburg, interesting them in this project.

PROF. C. E. FREEMAN, director of the Department of Electrical Engineering, Armour Institute of Technology, has been granted a leave of absence until Sept. 1st of this year. On account of overwork, Prof. Freeman finds himself compelled to take a complete rest.

MR. P. F. ROOHAN, superintendent of the Saratoga Springs Electric Light & Power Company, has been appointed manager of the light and power division of the Hudson River Water Company, with special charge of the plants between Albany and Glens Falls.

MR. H. M. WHARTON, for the last five years engineer of works for the Westinghouse Electric & Manufacturing Company, has accepted a position as one of the chief designing engineers for the Allis-Chalmers Company. Mr. Wharton was identified with the induction motor work of the Westinghouse Company.

MR. FRANCK Z. MAGUIRE, who is well known on both sides of the Atlantic, has opened offices for the sale of American and foreign patents. His London office has been established for eleven years and is now at 5 Warwick Court, High Holborn. In New York his headquarters are at the Astor Building, 10 Wall Street.

MR. WILLIAM C. HUBBARD, for several years with the Westinghouse Electric & Mfg. Company, has entered the sales department of the Cooper Hewitt Electric Company, New York City. Mr. Hubbard has had considerable experience in the lighting field, having been associated with Prof. L. B. Marks in the development and introduction of the first commercial enclosed arc lamp in this country. For two years he was vice-president and general manager of the Electric Arc Light Company, and afterward New York manager of the Manhattan General Construction Company until both companies were absorbed by the Westinghouse interests.

MR. ALBERT S. CRANE has joined J. G. White & Company as chief hydraulic engineer of that firm. Mr. Crane was graduated from Cornell University in 1891, and the following four years was employed on sewer and water works construction in Newton, Mass. Subsequently he filled the position of assistant engineer of the Department of City Works of Brooklyn; from 1898 to 1901 he was chief assistant engineer in connection with the Sault Ste. Marie water power department, and later was chief engineer of the Lake Superior Power Company. Since 1902 Mr. Crane has been principal assistant engineer of the Sanitary District of Chicago, and engineer for the 6000-hp water power development at Marseilles, Ill.

MR. C. W. RICKER, who for the past year has been connected with the electric traction department of the New York Central & Hudson River Railroad Company, has just accepted the position of electrical superintendent of power stations of the Interborough Rapid Transit Company, with headquarters at the Fifty-Ninth Street Station of the company. Mr. Ricker is a graduate in electrical engineering of the class of 1891, of the Massachusetts Institute of Technology, and after graduation entered the employ of the American Telephone & Telegraph Company, in New York. In 1892 he took the student's course with the General Electric Company, at its Lynn works, and the following year opened an office as a consulting engineer in Buffalo, where he remained six years. In 1899 he accepted the position of electrical engineer of the United Electric Securities Company, of Boston, and the following year became assistant to Mr. Theodore Stebbins, engineer of the Local Companies Department of the General Electric Company. While engaged on this work he was appointed engineer in charge of the Lima Electric Railway & Light Company, of Lima, Ohio, and upon completion of the work with which he was entrusted there entered the employ of the Cleveland Construction Company, of Akron, Ohio, and later became electrical engineer of the Miami & Erie Canal Company, his work with this company including the installation of a complete polyphase plant and locomotives for towing canal boats. In 1904 he resigned from that company to enter the electrical engineering department of the New York Central Railroad.

Trade Publications.

SILVER ANNIVERSARY.—W. C. Sterling & Son Company, Monroe, Mich., have sent out a card announcing the beginning of a second quarter century in the business of supplying poles and ties.

ASBESTOS AND MAGNESIA SUPPLIES.—In a recent publication, the H. W. Johns-Manville Company, New York, catalogues its long list of asbestos and magnesia manufactures, consisting of laggings, packings, roofings, etc.

SHAWMUT BUSHINGS.—Bulletin No. 31 of the Chase-Shawmut Company, Newburyport, Mass., illustrates and describes the copper planted and lacquered "Conduit Outlet Bushing." It is claimed that the saving in labor by the use of this conduit bushing exceeds its cost.

WARD LEONARD CATALOGUE.—The latest issue of the Ward Leonard catalogue, dated April 25, contains many illustrations showing the latest developments in the design of motor starters and field rheostats. This catalogue contains a bulletin listing motor field rheostats for use with variable speed motors.

ELECTRICAL DISPLAY ILLUMINATION.—The New Orleans & Carrollton Railroad, Light & Power Company has issued in pamphlet form a number of views of buildings, streets, etc., as illuminated electrically during the Mardi Gras festivities in March. Those interested in electrical illumination will find this publication of value.

WALL TELEPHONES.—Common battery wall telephones are among the things manufactured by the Dean Electric Company, Elyria, Ohio. The company has just issued a special folder, No. 31, on this particular line of instruments, which are well illustrated and briefly described. Diagrams show the circuits of the Dean common battery telephone system, and the general views of the apparatus indicate that the instruments are attractive and well made.

THE NATIONAL ELECTRIC COMPANY, of Milwaukee, is distributing a neat line of cards illustrated with half-tones showing various equipments which it has installed. A card recently issued dealt with the Christensen air-brake, a view being given of a suburban coach of the Cleveland, Elyria & Western Railway, which is equipped with this type. It is stated that there are more than 14,000 Christensen air compressors now in use throughout the world.

QUEEN & COMPANY, of Philadelphia, are distributing a new circular No. 1204, on condensers and self-induction apparatus. This circular shows a wide variety of condensers from the most elaborate standards down to the smallest tin-case condensers as used extensively in telephone work. Standards of self-induction, both fixed and variable types, are illustrated and described. There are also included curves showing the absorption and leakage in their standard condensers.

THE CENTRAL ELECTRIC COMPANY, Chicago, is sending out price list No. 10 covering D. & W. enclosed fuses and safety devices. In this price list every line of new code fuses is listed, and the arrangement and classification have been given careful consideration with the view to making it compact and convenient for quick reference. The Central Electric Company as general Western selling agent for D. & W. fuses and safety devices will mail one of these catalogues to any user of electrical material on request.

MAST ARMS.—The Buffalo Specialty Mfg. Company, Buffalo, N. Y., in a circular just issued describes and illustrates its Duplex Mast Arm, for which are claimed the following advantages and features: ease of operation, neatness, freedom from trouble and repairs, strength, lightness, rigidity and reliability. The arm remains always stationary on the pole, the lamp only being lowered or raised by a cable or cord. It is made of two lengths of steel tubing fitted into malleable iron sockets, thus giving a practically indestructible construction.

EUGENE MUNSELL & COMPANY and the Mica Insulator Company are sending to the trade a very handsome blotter printed in two colors announcing the fact that they have moved from No. 117 Lake Street to large and commodious quarters at No. 358 Dearborn Street, which is more in the center of the electrical district of Chicago. Both companies are experiencing a very large demand for their mica and "Micanite" materials. The trade west of Ohio and Pennsylvania is handled by the Chicago house, where the large stock carried enables them to make prompt shipments.

ELECTRICAL DATA.—The Chase-Shawmut Company, 390 Atlantic Avenue, Boston, Mass., has issued in a 24-page pamphlet a compilation of data of interest to the electrician. Tables are given of wire data, cable equivalents, decimal equivalents, amperes corresponding to the kw-capacity of generators and the hp-capacity of motors. Some general electrical formulas are included and sketches illustrate the connections of various classes of instruments. Definitions are given of electrical units, and in parallel columns are the analogies between the flow of water and electricity. Other matter consists of underwriters' rules applying to switches and fuses, a table of the melting point and conductivity of different metals and alloys.

THE WESTINGHOUSE COMPANIES.—With the title "The Westinghouse Companies in the Railway and Industrial Fields," a beautiful publication just at hand gives an account, historical and descriptive, of the various Westinghouse works, with incidental mention of some of the more remarkable apparatus that has been built in them. The cover is a beautiful specimen of artistic work, and the frontispiece consists of an admirably executed portrait of Mr. George Westinghouse. The various Westinghouse works are illustrated and some of the more interesting productions of each plant are described and shown. In the section devoted to the electrical works, a history is given showing their development from 1885 to the present day, and including an account in detail of the pioneer period of alternating currents development in this country. This handsome pamphlet was prepared for distribution at the International Railway Congress now in session at Washington.

News of the Trade.

INTERNATIONAL ELECTRICAL EXHIBITION.—The management of the Internatonal Electrical Exhibition at Boston, in July, has contracted with the Minimax Fire Extinguisher Company to place a large number of its extinguishers about the building to safeguard the property of the exhibitors.

THE ELECTRIC APPLIANCE COMPANY is now located in its new Chicago home at 134 to 140 West Jackson Boulevard. The new building, which is the largest warehouse in the world devoted exclusively to electrical supplies, gives added facilities for the prompt handling of its increasing business.

THE CROUSE-HINDS CO., maker of switchboards, panel boards, knife switches, Norbitt specialties, and Hawley time registers, has removed its offices from the ground floor of the Havemeyer Building, 23 Dey St., New York, to more commodious quarters on the eighth floor, room 804, of the same building.

THE DIELECTRIC COMPANY, of St. Louis, has opened offices at 138 Liberty St., New York, for the sales of its material for machine insulation, including insulating paints and varnishes, rope and press boards, tape and sleevings, cable and coil compounds, fibres and fuller board, mica products in all forms and Heany asbestos-covered wire.

KOHLER BROS., of Chicago, through their Pacific Coast branch, the Abner Doble Company, of San Francisco, have recently installed their system on a new press of the Portland *Oregonian*, and have closed contracts with the *Times-Mirror* Company, Los Angeles, Cal., and the *Spokesman-Review*, of Spokane, Wash. The Kohler system consists of a multiple push-button control for the electrical operation for printing presses and other machinery. The *Oregonian* has a 50-hp equipment, and the proprietors are exceedingly well satisfied with the good results attained.

THE L. B. ALLEN COMPANY, INC., 1332 Columbia Ave., Chicago, Ill., is making a special effort to introduce its Sun soldering stick during the month of May. The stick has had a great deal of favorable commendation on the the part of those who have used it, but like everything that is introduced into a market there are some who hesitate about trying a thing that is new or different from what they have been accustomed to. In order to get the Sun soldering stick into the hands of a good many users this special offer has been made. One of the customers of the L. B. Allen Company has asked in a recent letter for a sample of the Allen salts, saying that if they are as good and non-corrosive as the Allen soldering stick he can use a great deal of it. A willing experimenter is a valuable aid in the advance of the industrial arts.

WARD LEONARD MOTOR CONTROLLING PANELS.—The motors in the new building of the C. D. Kenney coffee roasting plant are equipped with the most modern controlling apparatus. Messrs. Adams & Swab were the consulting engineers, and the Ward Leonard Electric Company's SUN and SKN types of controllers were installed. Each panel consists of an overload and no-voltage release motor starter with extension slate, switch and fuses. The overload circuit-breaker is so interlocked with the motor starter that the circuit cannot be closed unless the starting arm is in the protective position. This insures positive protection against overloads at all times, and prevents the possibility of closing the circuit upon a short circuit. It is a great advance in the art when commercial houses are adopting fireproof and "foolproof" apparatus.

COMPLETE GENERATING SETS.—Although the papers are full of illustrations and descriptions of small and medium sized generating sets, it is surprising how few manufacturers build both the engine and the generator. Among these few is to be numbered the B. F. Sturtevant Company, of Boston, Mass., which has, with painstaking care, during a period of fifteen years, gradually perfected a line in which the engine and the generator have been designed the one for the other. The engines are entirely enclosed, with forced lubrication, large bearing surfaces and watershed partitions between cylinder and frame; while the generators are designed to meet the most exacting conditions of continuous operation. The result is a unit possessing the maximum of mechanical and electrical efficiency. These sets are built in a full line of sizes in both the vertical and horizontal types, ranging from 3 to 250-kw output. The smaller sizes are compacted upon a single bed plate, ready for immediate shipment as individual units.

EXTENSIVE HEATING SYSTEM.—The magnitude of the Canadian Pacific Railway Company's new Angus shops at Montreal is plainly evident from the fact that no less than thirty-seven miles of steam piping was massed in the Sturtevant heaters which were installed in connection with the blower heating system. Before a decision was reached a thorough comparative study was made of the different systems of shop heating by direct steam and hot water and by blower methods. The latter was finally adopted as being the most efficient and economical where the requirements are so severe on account of the large spaces to be warmed, the high proportion of window area and the low external temperature. The apparatus was built and installed by the B. F. Sturtevant Company, of Boston. Steam is distributed in tunnels to the different buildings from the central power-house, which is about 2600 feet from the most distant part of the system. The buildings have a combined volume of about 26,000,000 cu. ft. From ¼ to ½ of the wall surface is glazed, besides which there are skylights aggregating 25 per cent. of the roof surface. The specifications require most of the buildings to be heated to a constant temperature of 65 degrees when the temperature outside is 10 degrees below zero. The radiators for this service are arranged at local points in vertical coils with cast-iron bases, which are coupled up in groups. The fans which draw the air through these heaters are calculated to have an hourly capacity of the enormous volume of about 80,000,000 cubic feet, sufficient to completely change the air in every building once in about every 20 minutes. In very cold weather, however, a closed circulation is maintained and the air returned to the heaters without receiving any access of cold air from outside.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED MAY 2, 1905.

[Conducted by Rosenbaum & Stockbridge, Patent Attys., 140 Nassau St., N. Y.]

788,513. RAILWAY SIGNAL SYSTEM; Abram L. Bower, Boyertown, Pa. App. filed May 3, 1902. Has a polarized relay within the locomotive and local circuits to display neutral, safety or danger signals therein. Track circuits operate to send currents of opposite directions through polarized relay according to condition of the block.

788,518. SWITCH AND CONNECTIONS CONTROLLING ELECTRIC MOTORS AND POWER TRANSMITTERS; Herbert B. Coho, Mount Vernon, N. Y. App. filed Sept. 17, 1903. A clutch controllable at will upon a motor shaft and a snap-switch located in the motor circuit is connected to be thrown suddenly when the clutch is operated.

788,526. ELECTRIC TROLLEY WHEEL; Theophile Euphrat, Norwalk, Conn. App. filed Aug. 25, 1904. Includes a pair of toothed plates on opposite sides of the trolley wheel and a hand adjustment for throwing said toothed plates inwardly whereby they engage the trolley to remove ice therefrom.

788,536. PNEUMATIC RAILWAY SIGNALING SYSTEM AND ELECTROPNEUMATIC VALVE THEREFOR; Ernest Copeland, Irving, Westminster, England. App. filed March 14, 1903. A solenoid is connected to an air valve of special construction arranged to open the valve when the solenoid is de-energized.

788,539. DEVICE FOR CONTROLLING ELEVATOR LIGHTS; George C. Klopf, Chicago, Ill. App. filed Feb. 4, 1903. The elevator has a switch projecting therefrom which is engaged by push buttons or levers upon the different floors.

788,540. ELECTRIC LIGHT BATH CABINET; Richard Kny, Brooklyn, N. Y. App. filed Jan. 3, 1905. The invention relates to the construction of a knock-down cabinet having electric fixtures therein.

788,557. ELECTRICAL OZONIZER; Carl A. Sahlstrom, Ottawa, Canada. App. filed June 21, 1904. A box contains a motor driven rotary circuit breaker of special construction over which a current of air passes.

788,562. ELECTRICAL RAILWAY SIGNAL; James W. Tatum, Durham, N. C. App. filed Oct. 19, 1903. A safety device for electrical trains. The trolleys are insulated into sections and two trains upon the same section close warning circuit. Second trolley with shorter sections provides similar and further warning.

788,563. MEANS FOR ESTABLISHING ELECTRIC CIRCUITS; Guion Thompson, Duluth, Minn. App. filed July 1, 1902. An electro-magnet is carried by the train and passes adjacent to a stationary magnet on track energized by another train. If both are simultaneously energized, a safety or other signal is made. The train magnet also throws a circuit breaker on the track to open the above-made circuit.

788,566. ELECTRIC MOTOR AND POWER TRANSMITTER; Orville R. Van Vetchen, New York, N. Y. App. filed Sept. 17, 1903. A mechanical clutch on the motor shaft has a special construction to throw the motor circuit switch suddenly when the clutch is released.

788,624. RAILWAY SIGNAL; John Bildson, Chicago, Ill. App. filed Feb. 16, 1904. This comprises a complete railway block system, the circuits of which may be readily traced.

788,686. RESISTANCE FOR ELECTRICAL CIRCUITS; Hermon L. Van Valkenburg, Pittsburg, Pa. App. filed Aug. 6, 1904. Resistance coils having detail improvements. Resistance wire coiled on asbestos covered iron rods separated by insulating porcelain beads.

788,704. ELECTRIC STRIKING CLOCK; Ulysses L. Collins, St. Louis, Mo. App. filed Feb. 23, 1904. Upon the hour a circuit is completed which energizes the gong magnet which continues to strike until the usual cam devices have been stepped along far enough to break the circuit.

788,747. ELECTRIC DISPLAY APPARATUS; Edmund L. Zalinski, New York, N. Y. App. filed Oct. 6, 1904. Lamps of special form of frosted glass; also elbow and T-shaped sockets therefor providing electrical signs composed directly of the incandescent bulbs.

788,762. ELECTROMAGNETIC DEVICE; Albert Favarger, Neuchatel, Switzerland. App. filed Nov. 25, 1902. An electro-mechanical movement for converting an alternating current into step by step movement. Electromagnets in an alternating circuit act directly on a polarized notched disk of special form to turn the same.

788,776. RAIL JOINT; Oswald F. Jordan, Chicago, Ill. App. filed Feb. 11, 1904. Insulation for the rail joint is provided by surrounding the bolts thereof with insulating collars. Details.

788,792. CLOCK SYNCHRONIZING SYSTEM; Harry W. Pidgeon, Chicago, Il. App. filed July 29, 1904. The master clock throws a telephone circuit into electric connection with the timing devices ten seconds before the hour. One second before the hour the circuit is energized and on the hour it is broken. The breaking of said circuit, through relay magnets, energizes powerful solenoids at each secondary clock, whose armatures, acting on the cam or arbor gear of the minute hand, accurately set the same. Ten seconds later the circuit is reconnected to the usual telephone switchboard.

788,800 TELEGRAPHY AND TELEGRAPH APPARATUS; Wesley Trafford, New York, N. Y. App. filed March 15, 1897. A time clock in which a check is punched with holes whose lateral position indicates an ordinal. When fed under suitable contacts, circuits are made to the recording typewriter. This has a motor driven type-wheel and sunflower stop therefor whose local circuits are operated by a local carriage which is stepped along by an impulse current from the transmitting end of the line. Synchronizing is effected by the nature of the circuits.

788,819. ELECTRIC-MOTOR STARTING AND STOPPING DEVICE; John H. B. Bryam, Buffalo, N. Y. App. filed March 14, 1904. (See Current News and Notes.)

788,872. AUTOMATIC ELECTRIC LIGHT CONNECTION FOR AUTOMATIC RAILWAY BLOCK SIGNALS; William Alloway, Caledonia, N. Y. App. filed March 22, 1904. The contact rails are divided into insulated blocks or sections and the separate rails are maintained at different potentials. When short-circuited by a train, a contact is made, lighting the signal lamp at the same time as the spectacle lens moves into position.

788,880. ADJUSTABLE OUTLET BOX FOR INTERIOR CONDUITS; William F. Bossert, Utica, N. Y. App. filed April 26, 1904. The outlet box is designed to telescope into the main conduit and has a stamped groove thereon to lock it in position.

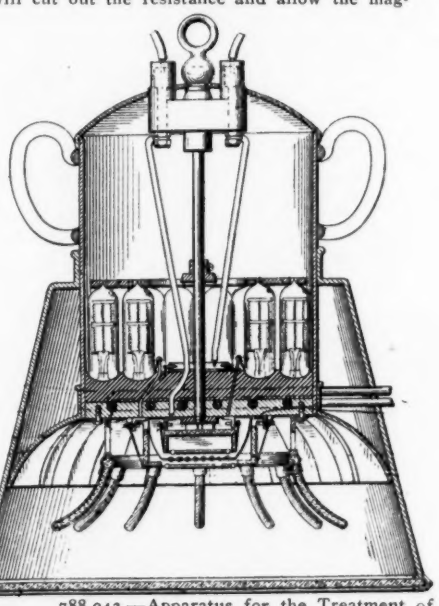
788,916. ELECTRICAL SWITCH MECHANISM; Hubert Krantz, New York, N. Y. App. filed Dec. 6, 1904. Fixtures for bus bars adapted to be stamped from sheet copper. They are bent so as to engage the bus bar and at the same time form a support for the usual cross bars.

788,917. ELECTRICAL DEVICE; Hubert Krantz, New York, N. Y. App. filed Dec. 6, 1904. A fixture for panel boards adapted to be stamped from sheet copper. It is folded in such a way as to form a connection for the fuse and contact blade for a knife switch.

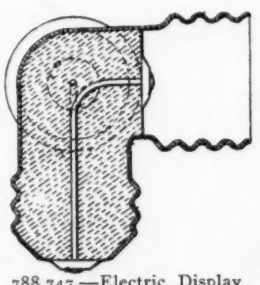
788,924. TELEPHONE SWITCHBOARD ANNUNCIATOR; Charles Thomas Mason, Sumter, S. C. App. filed June 10, 1904.

788,943. APPARATUS FOR THE TREATMENT OF CERTAIN DISEASES; Arthur H. Pohl, Chicago, Ill. App. filed Oct. 31, 1904. A metallic casing contains a series of glowers virtually forming a Nernst lamp. They are incidentally heated by a Bunsen burner. Radium tubes are also provided. The bottom of the casing is of glass so that it may be applied to the body.

788,959. ELECTRIC CIRCUITS AND APPARATUS FOR RAILWAY SIGNALING; Henry W. Spang, New York, N. Y. App. filed Aug. 21, 1902. A semaphore signal in which the track has a short insulated section, the rails of which are connected to the terminals of a resistance. This resistance is in series with a magnet which is in circuit with the succeeding track section. If such succeeding section is clear, then a train passing onto the short section will cut out the resistance and allow the magnet to be sufficiently energized to display the safety signal. If, however, the succeeding section is not clear, the magnet will be short-circuited and not energized. The resistance is formed into an impedance or choke coil to prevent lightning from injuring the magnet. Since the semaphore cannot be displayed to the safety signal till the engine arrives at the short section, the previous appearance of such safety signal notifies the engineer that the mechanism is out of order.



788,943.—Apparatus for the Treatment of Certain Diseases.



788,747.—Electric Display Apparatus.

788,990. SYSTEM OF ELECTRIC CAR LIGHTING; Richard D. Apperson and Albert J. Kohler, Lynchburg, Va. App. filed March 24, 1904. Two switches are arranged on top of the car in circuit with the display lights at each end of the car, so that when the trolley is swung around the proper switch will be closed.

789,014. TROLLEY; Charles M. Feist, Sioux City, Ia. App. filed Aug. 24, 1904. A lubricating device for the trolley having certain special features. The axle is in two parts, spring-pressed outwardly so as to avoid sparking between the axle and wheel.

789,030. ELECTRIC SIGNAL SYSTEM; Robert O. Johnston, Brooklyn, N. Y. App. filed March 30, 1904. At each station of a railway block system an indicator is provided. Each indicator has a series of magnets which are successively energized as the train passes over the different track sections, so that each indicator will automatically show where the train is.

789,040. ELECTROTHERAPEUTIC APPARATUS; Charles F. Marsh, Pensacola, Fla. App. filed Dec. 3, 1903. An electro-static machine is provided with a sort of impedance coil having connections in a peculiar way by which the patentee states vacuum tubes may be operated to produce rich ultra-violet rays.

789,082. SAFETY DEVICE FOR ELECTRIC CURRENTS; McKelvey Crites, Cleveland, Ohio. App. filed Sept. 22, 1904. The usual motor rheostat arm has a cam which releases a gravity contact when the arm is moved to start the motor. The gravity contact is, however, held up by a solenoid when the motor is in operation. If the circuit is broken, the solenoid lets the gravity arm drop. The rheostat arm does not fly back to the "off" position in this construction.

789,083. SAFETY DEVICE FOR ELECTRIC CURRENTS; McKelvey Crites, Cleveland, Ohio. App. filed Dec. 27, 1904. Relates to improvements in the above patent. The rheostat arm is permitted to fly back in this construction. The gravity contact above referred to is also initially broken, but is reset when the rheostat arm has been returned.

789,087. ART OF ELECTRICAL-WAVE TRANSMISSION; Cornelius D. Ehret, Washington, D. C. App. filed Dec. 3, 1901.

789,124. ELECTRICAL-WAVE TRANSMISSION; Cornelius D. Ehret, Rosemont, Pa. App. filed Dec. 3, 1901.